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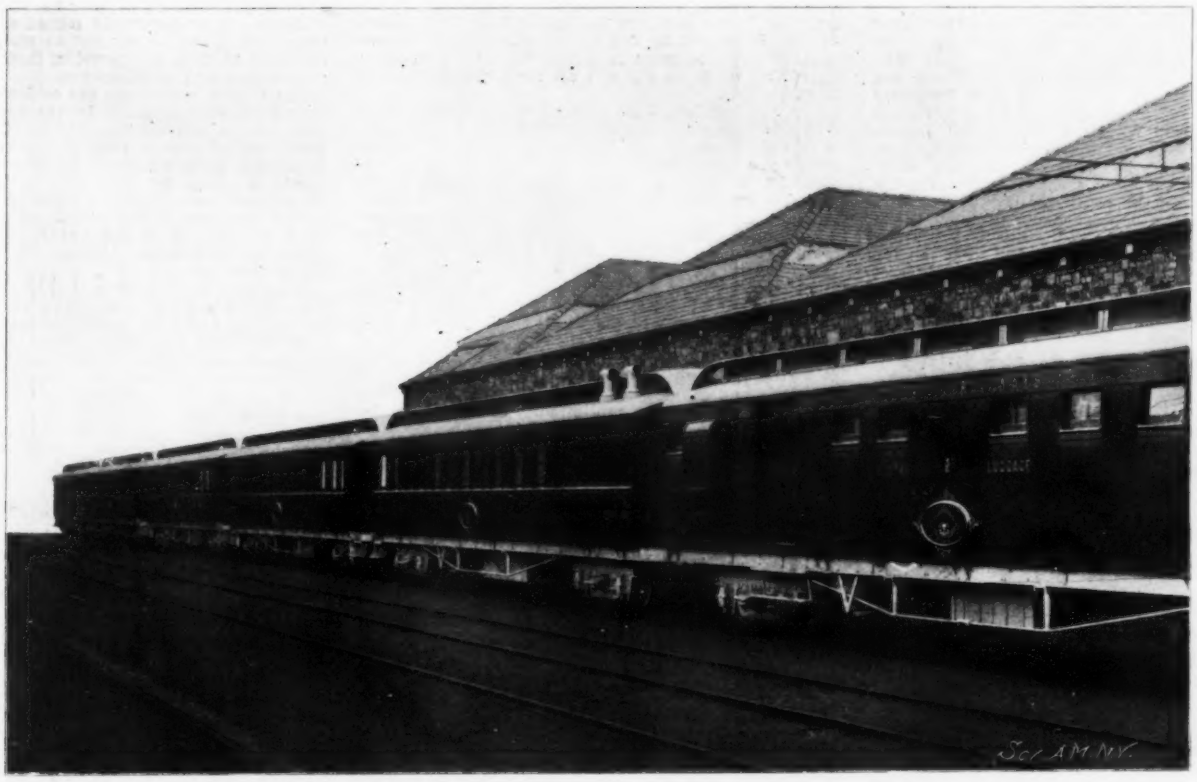


THE TRAIN DE LUXE OF THE "CAPE TO CAIRO" RAILWAY.

DINING-CAR OF THE "CAPE TO CAIRO" TRAIN DE LUXE.

THE TRAIN DE LUXE FOR THE CAPE TO CAIRO RAILWAY.

A handsome *train de luxe* for service between Cape Town and the more remote towns in Rhodesia, already connected by means of the Cape to Cairo Railway, has been shipped to South Africa. The railway at present extends to Buluwayo, a distance of 1,361 miles, so that a journey over this whole length of line must necessarily be somewhat fatiguing. The directors of this railway, through the influence of Mr. Cecil Rhodes, have determined to reduce the tedium of such a long journey, as far as possible, by the supply of a comfortable train, and that dispatched to South Africa is the first of several that will be subsequently supplied as the construction of the railroad progresses. Compared with the long-distance trains plying upon the railroads of this country, and also those of Europe, this *train de luxe* is in every way up to the standard, and should be warmly appreciated by the travelers through monotonous veldt and the uninteresting country in the Limpopo and Zambesi districts.

The train consists of six coaches, with four-wheel trucks, comprising a combination postal and baggage car; dining car, complete with kitchen and pantry; three convertible day and sleeping cars; and a sixth car containing buffet, smoking room, library, card room and observation platform at the rear.

The cars each measure 56 feet in extreme length, by 8 feet 6 inches in width, and are built to the gage of the South African railroads, which is 3 feet 6 inches. The frames of the cars are of steel. The carriages are finished in wainscot oak, which has been generally employed throughout. The pilasters and mouldings are of a darker tone and set off admirably the lighter colored paneling work. The upholstering is of crimson leather, which combines harmoniously with the woodwork. Lincrusta of a quiet pattern constitutes the roof decoration, while the ventilator is provided with beautifully decorated windows. The sliding doors giving access from the corridors to the saloons are 3 feet wide. The sliding doors are suspended from the top with idle rollers on guide rails. The windows are of the type generally adopted by English railroad companies, and can be adjusted to any height, being raised and lowered upon steel copper-taped sashes fitted with springs.

The dining saloon has accommodation for twenty-four persons. An innovation in the designing of this apartment has been in the deviation from the general practice of fixing the chairs to the floors.

The three ordinary compartment cars have four double-seated and one single-seated compartment. The former are available for four and the latter for two sleeping berths. The corridor is 1 foot 8¾ inches wide, and the length of the compartment permits of the provision of a bed 6 feet in length. The compartments are provided with temporary tables with folding flaps, so that no obstruction is offered in passing to and fro.

In the conversion of the squab of the cushion for the upper sleeping berth an ingenious arrangement, patented by the Lancaster Company, has been adopted. As a rule, this squab has a reverse back curve, since this shape is generally conceded to be the most comfortable. When slung upward, however, owing to the presence of this curve, the bed has to be built up level to render it comfortable for sleeping purposes. By means of the device adopted in this instance, however, the squab in being raised is turned completely over, so that the reverse side of the squab, which is constructed upon the principle of a spring mattress, becomes the upper surface of the bed, and being perfectly level only requires the ordinary hair mattress to convert it into a comfortable bed. The front of the berth is suspended from the ceiling by brass rods. The mattresses are stowed away in a cupboard underneath the seat, out of the way. The bed can be prepared for the passenger in two minutes.

Another salient characteristic is the bathroom. The apartment is about 6 feet in length by 4 feet in width. The water for the bathroom is stored in a tank fitted to the underframe of the car, and is raised to the overhead cistern by a hand pump.

The combination car, comprising library, smoking saloon, and various apartments, is luxuriously equipped. At the observation end of the carriage is the saloon fitted with a lounge, tables, and wicker chairs, all conducive to extreme comfort. This saloon occupies one-half of the car. In the remaining portion is the cardroom, a small compact compartment with an envelop table and four armchairs, with the buffet adjoining. From the buffet access is gained to the smoking saloon, which occupies the remainder of the car.

In the baggage car, folding-down hammocks and a reserve of hammocks for utilization in the dining saloon on those occasions when the number of passengers exceeds the sleeping accommodation provided, are carried.

The train is lighted throughout by electricity. The dynamos for generating the current are fixed in the underframe of the cars and are driven by a belt passing round the axles of the wheels. Reserve accumulators are carried for supplying light during the intervals the train is at a standstill. The light is supplied for the most part by means of eight-candle power lamps, but in the public saloons, ornamental electroliers with a cluster of four eight-candle power lamps are supplied. The train is adequately ventilated throughout with fans set in decorated boxes.

The train was completed ready for shipment to South Africa some weeks ago, but transportation to the Cape was postponed owing to the war. It was shipped to Cape Town in sections, where it was reconstructed and used by the Duke and Duchess of York in their journeys in Cape Colony.

Iron Sands of Guadeloupe.—Consul Aymé, of Guadeloupe, under date of August 13, 1901, reports that, according to a decree recently published in the Journal Officiel, a concession for the exploitation of the iron sands of the colony has been granted to Mr. N. de La Roncière, merchant and president of the chamber of commerce of Pointe a Pitre. The consul adds:

These sands are found at many places along the coast in vast beds. The quantity in sight and immediately available is estimated at some 200,000 tons. It is a very pure magnetic iron sand, free from impurities, and yielding about 67 per cent of iron. The iron is said to give a superior quality of steel. This consulate has been in receipt of several letters asking for particulars regarding these iron-sand deposits, but it has heretofore been the policy of the government of the colony to forbid the working of them. Practically unlimited quantities can be furnished, and vessels can be loaded very speedily and safely. All persons interested should write, either in English or French, to Mr. Numa de La Roncière, Pointe a Pitre, Guadeloupe, or to the American Exchange, same city.

THE PHYSICAL CONDITION AND SAFETY UNDER PRESENT LOADS OF THE NEW YORK AND BROOKLYN BRIDGE.*

Our examination of the New York and Brooklyn Bridge shows us that while no serious deterioration of the structure now exists, the supervision, inspection and maintenance are at fault in not removing various influences which tend to cause deterioration. The accident of July 24, 1901, when the breakage of two suspenders remained undiscovered until seven more failed entirely, shows the methods of supervision and inspection to be very faulty. The supervision has also been faulty in a more general and important sense. Statements as to the safety of the bridge have been issued without obtaining, by the use of all available knowledge, the real stresses in the structure. Without a knowledge of these stresses all such statements are unwarranted.

Our investigation of the strength of the bridge shows that it is now practically as strong as when completed. It also shows that, while the moving loads now on the bridge are about 40 per cent in excess of those proposed by the designer, his preliminary estimate of the probable weight of the structure itself was so much larger than its present actual weight that the combined weight of the structure and moving load is now less than 3 per cent in excess of that assumed by him in 1882. An increase in moving load, however, exerts a much greater effect on certain parts of the structure than would be caused by an equal increase in the structural weight. Some of the increases in moving load, also, were accompanied by reductions in the weight of floor which tend to decrease its safety. It is therefore true that, while the present combined weight of structure and moving load is very little larger than that of the designer's preliminary estimate, the increases in the moving load have reduced the safety of the bridge below that contemplated by the designer, and still more below that which is actually possessed before these increases in moving load occurred.

Our investigation shows that the stresses in cables, towers, parts of stay system, and floors, due to the most unfavorable probable combination of forces, are far in excess of those considered good and adequately safe by engineers. This is due both to increases of the moving loads above those at first contemplated and to various features of the original design. We consider it necessary that these excessive stresses should be reduced as soon as possible, and have suggested in the report below how this may be done at a comparatively small cost. The broad general statements above require amplification, which is given below.

The Accident.—On the evening of July 24, 1901, it was discovered that nine consecutive suspenders of the bridge were broken. These suspenders were at the center of the main span and on the north cable. Two of the suspenders had been broken a long time, while those next to the unbroken ones were free from rust and had been only recently broken. The suspender rods which failed were intended to resist tension and such small bending stresses as would arise from a swinging of the rods in the direction of the bridge on lubricated trunnions. The two rods at the middle of span (those which had been broken a long time) were also under a tension, during hottest weather, about 1½ times as great as in the case of other rods. The rods were of ample strength to withstand all these forces, however, and the failure must have been due to other causes.

An examination of the suspender rods shows that they must (because of their design) be subjected to side bending and that their failure is due to this. We believe the most important cause of side bending is wind pressure. The wind blowing against the platform and cars causes a pressure transverse to the bridge. Much of this pressure, especially near the slip joint at the middle of main span, must be transferred from the platform to the cables above. The only means by which it can be transferred is through the suspender rods, and then only by bending the rods, as the trunnions which were intended to provide for a motion of the rods in the direction of the bridge will prevent any motion transverse to it. The wind pressures transferred by these rods are large in amount and we believe are in themselves, by repetition since the completion of the bridge, sufficient to have caused the failure of the two middle rods.

At least two other causes of side bending act in conjunction with the wind pressure. An examination of the new rods which have replaced the ones which broke shows that they are being pulled to the north by the cable and are bearing hard against the top edges of their trunnions. This must be due to some defect of adjustment or construction by which the rods fail to lie in the plane of the cable, or the trunnions fail to be perpendicular to this plane.

The remaining cause of side bending is the only one (unless the whole design of the suspender rods be changed for the better) which could have been remedied by more careful supervision. The rods were intended for use with *lubricated* trunnions and the trunnions show no evidence of lubrication. The one removed and taken apart for examination was fixed tightly in the plates by rust and paint and must certainly have caused bending of the rod in the direction of the bridge.

The breaking of the seven other suspenders is directly due to the two rods broken first having been allowed to continue in the structure. This was due to inefficient supervision and inspection, which will be treated more fully below.

The accident shows that the rod suspenders are of insufficient strength to withstand the actual conditions existing, and that similar failures may occur on the other cables. The necessity is therefore apparent of very thorough and close supervision.

It was in our opinion wise to lighten the loads on the bridge by a partial stoppage of traffic when the breaks were discovered, as the indications are that the breakage would otherwise have spread to more of the suspenders and might have reached serious proportions. The accident is more fully treated in Appendix A.

Deterioration of Bridge and Responsibility Therefor.—We believe the following facts, many of them described in greater detail in Appendix B and C, to show that the officials in charge of the New York and Brooklyn Bridge have been neglectful and careless in their supervision and maintenance of the structure.

Many of the diagonal bars and sway rods of the stiffening trusses have been allowed to wear by rubbing against each other, and many of the suspender ropes by rubbing against the floor of promenade. No effort has been made to prevent such wearing, though it could easily have been prevented at any time since the completion of the bridge.

Water and mud have been allowed to collect and remain in portions of the bottom chords, and road sweepings in bottom of floor beams around suspender stirrups. It is commonly admitted that such conditions should not be allowed in steel bridges and the existence of them is a proof of inefficient and careless supervision and maintenance.

The saddles supporting the cables on tops of towers, now fixed, were intended by the designers to be movable, and an efficient supervision of the bridge would have used all means necessary to keep them so. Our inspection, however, shows no efforts whatever in this direction, ridges of rust, paint and dirt being found on the bed-plates along the outer rollers.

The trunnions at the bottom of the suspender rods were intended to be lubricated. They show no evidence of lubrication, though this could have been easily provided for.

A number of the stirrup rods of the wire suspenders were found improperly adjusted. This condition could occur only under an inefficient method of inspection.

Of the nine suspenders which were discovered to be broken on July 24, two had been broken a long time. The presence of these two broken suspenders in the structure, undiscovered, proves that the inspection of the bridge must have been either very infrequent or merely nominal, at least so far as regards this detail. The necessity of frequent and thorough inspection of this special detail should have been recognized by the Bridge Department, as it was stated by them, after the accident, that similar breakages had occurred at previous times. It was evidently their duty, in view of the recognized liability to breakage of these rods, either to replace them by some new device better adapted to withstand the forces acting, or at least to make such frequent and thorough inspection that any broken rod would have been discovered within a day or two after the break occurred. The inspection actually made, however, was of a nature which allowed the two rods first broken to remain undiscovered in the structure for a long time and until the break had spread to seven others, and it was even said, we do not know with what truth, that even then the breakage was not discovered by employés of the Bridge Department.

It has been stated that no ordinary method of inspection would have shown the breakage of these rods and that if the break occurred below the top of the trunnion it could not have been discovered until the broken end appeared above the top. One of the commonest ways of testing the soundness of such parts of a bridge is by blows of a hammer. A broken rod—or even an unbroken one having very little stress in it—can be detected without difficulty by its sound under such blows. This was recognized by the Bridge Department, as shortly after the accident all the remaining rods of the north cable at center of main span were so tested by them, as shown by defacement of the paint where the rods were struck. This test by hammer blows, however, was even then applied to only a few of the rods on the other cables, though many of these rods were just as liable to failure as those which actually did fail at the northernmost cable.

A merely visual inspection, without the use of the hammer, is also sufficient to show the breakage of a suspender rod. The least lifting of a rod will break the paint film connecting the rod with the top of the trunnion or bring into view a portion of the rod, unpainted or differently painted, which was before within the trunnion. With the former condition of the paint known, either of these changes in appearance should be sufficient to excite suspicion as to the soundness of the rod, and to cause more conclusive tests with the hammer or the wrench.

The method of inspection in vogue on this bridge is at direct variance with the methods in general use on good American railroads. The usual methods (as shown in Appendix E) are to have the inspection made by engineers in person, at stated intervals (once, twice, four times, or even—in one case of which we have been told—twelve times per year) and the results recorded on printed forms which make it impossible, without falsehood, to forget or neglect any special features.

The inspection on this bridge seems to have been done entirely by mechanics, at no stated times, and with no record sheets returned to the office as a guarantee that the inspection had actually been made. In our opinion this method of inspection is nominal only and entirely inefficient. That it cannot be depended upon to keep the bridge in a safe condition is clearly proven by the failure, under its continuance, to discover the two broken rods in time to prevent the break spreading to other rods. The safety of the bridge demands that the method should be changed at once to that generally recognized as the best—an inspection by engineers in person, at frequent stated intervals, and with the results recorded on printed forms. With the bridge in its present condition, we believe that some parts of it should be inspected daily, others weekly, and every part at least monthly.

In addition to the facts given above, we believe the supervision of the bridge has been lax and inefficient

* Report by Edwin Duryea, Jr., M. Am. Soc. C. E., and Joseph Mayer, M. Am. Soc. C. E., to Eugene A. Philbin, District Attorney, New York City.

in a more general and important way, as specified below: No exact records have been kept of the condition of the structure, and no complete and correct set of drawings exists. Without these it is impossible to calculate the actual stresses, which must be known before any definite and reliable statement can be made in regard to the degree of safety of the bridge. A careful supervision would have kept such records and would have made calculations of the actual stresses in every affected part whenever any changes were made in either load or structure; it would long since have discovered and remedied the weakness of various parts of the floor.

An efficient supervision would have studied all the published scientific discussions of suspension bridges and would have been warned by statements made by eminent engineers in the Transactions of the American Society of Civil Engineers that large secondary stresses occur in *wrapped* cables of suspension bridges having stiffening trusses with center hinges. It does not require any unusual ability to know, after attention is drawn to the fact, that secondary stresses of considerable amount must exist in the cables of this bridge. The engineers in charge of the bridge should have either calculated these secondary stresses to assure themselves that the stresses are not of dangerous amount, or should have suggested changes which would reduce these stresses to safe amounts. No statements should have been made in regard to the safety of the bridge until after all available knowledge had been used to determine the stresses, which must be known before any reliable assertion is possible. The amount of knowledge and care here specified is necessary to secure the safety of the public.

Such deterioration as has occurred has not appreciably diminished the strength of the structure as a whole. This will be taken up below under Safety of the Bridge. The bars and rods which have been somewhat worn by rubbing were larger than necessary to begin with, and are still of ample strength for their duties. The same is true of such members as have had their sections reduced by rust. The immovability of the saddles increases the stresses in tower masonry considerably, but in another way exerts a good effect on the bridge by keeping the stresses in cables at center of main span lower than they would be if the saddles were movable.

SAFETY OF THE BRIDGE UNDER THE PRESENT LOADS.—In taking up this part of our report it is necessary to explain just what is meant among engineers by the term safety as applied to a structure. In discussing the strength of engineering structures the term "Factor of Safety" is constantly used. By this is meant the ratio between the stress which would cause sudden failure from a single application and that actually existing in the structure or member. The latter stress is called the working stress of the material and the former its ultimate strength. Though the factor of safety of a structure is by common practice fixed with respect to the ultimate strength of the material, there is a much smaller stress under which it will fail slowly if the application is repeated many times. This stress is called the elastic limit or the elastic strength, and is about six-tenths of the ultimate strength in the case of structural steel and over two-thirds for steel wire.

In the case of structural steel having an ultimate strength of 60,000 pounds per square inch, and a working stress of 20,000 pounds, the factor of safety is said to be 3, though under a stress of 36,000 pounds per square inch, repeated millions of times the structure would slowly fail. Experience has taught that because of a lack of complete knowledge of the quality of each piece used in a structure and of all the stresses existing, it is never prudent (even when all the known stresses are considered) to use working stresses in excess of about two-thirds of the elastic limit. When the added destructive effect of moving loads is not included in the stress, the working stresses are made much smaller.

It is evident, therefore, that the same so-called factor of safety gives very different degrees of real safety according to the kind of material used and according to the methods and completeness with which the stresses in the structure are determined. If the material used is very uniform in quality and with its elastic limit high in proportion to its ultimate strength, the real safety of the structure will be greater than otherwise. If the stresses used in proportioning a member include all the secondary stresses, the real safety obtained with the same "factor of safety" is much greater than if only the principal stresses are considered. The only safe course in dealing with uncommon structures or details is to calculate all the determinable stresses and then choose such a factor of safety that there is a certainty that the actual working stresses which may occur shall always be well below the elastic limit, in all parts of the structure. This certainty of safety can be attained only when the details are so designed that those stresses which cannot be accurately calculated are small.

The mere statement that a certain bridge has a given factor of safety means little. Unless it is known how the stresses were calculated, what ones were included and what omitted, what is the uniformity of the material and the ratio between the elastic limit and its ultimate strength, and what are the details of the bridge, no opinion of value can be formed as to its real safety. The present safety of the bridge can therefore be determined only by calculating all the stresses of considerable size and then comparing these stresses with the present strength of the corresponding members, as determined from the working stresses considered safe by the best practice. If the safety is found to be defective, this may be due to any one of the following four causes:

(1) Physical deterioration of the materials or members;

(2) Changes made in the structure since its completion;

(3) Increases of moving loads beyond those for which the bridge was designed; and

(4) Defects in the original design.

PHYSICAL DETERIORATION.—This might ensue from a reduction of the sections of members by rusting or wearing, or from a reduction in the strength of the steel due to a repetition of stresses near the elastic limit. The latter cause cannot have occurred except in a few details; notably the stirrups of stays and of some of the suspenders, and in the suspender rods near the center of main span. The physical examination shows that the reduction of section by rust and wearing are in no case serious and do not exist in the members having the smallest factors of safety. Electrolysis has often been mentioned in newspapers as a possible cause of weakening of the bridge. This is merely a form of rust caused by electricity under certain conditions, and there is no evidence that these conditions exist in the bridge. In our opinion no material loss of strength from physical deterioration has occurred in the bridge.

CHANGES MADE IN STRUCTURE.—The only change known to us is a lightening in the weight of railroad floors by widening the spaces between ties and omitting the tie-spacers (guard rails). This change reduces the safety of the structure locally in case of derailment, but if it had not been made, the already too small factor of safety in the cables would have been still smaller.

INCREASE OF MOVING LOADS.—The moving loads on the span as a whole have already been partially treated. They are seen to be much larger than those proposed by the designer. The load from trolley cars varies greatly with the interpretation and enforcement of the 102-foot spacing between cars. The Board of Experts which in 1897 reported on the safety of the bridge and the practicability of allowing trolley cars and elevated trains to use it recommended that this spacing be made 102 feet clear distance between cars, while the Bridge Department, to judge from a report made in December, 1898, seems to have adopted a spacing of 102 feet front to front. We have adopted the latter as our moving load, as it may be inferred to be the regulation and in any case seems to us nearer the actual condition. This interpretation increases the load from present heaviest trolley cars to about 136 per cent of what it would be for 102 feet clear distance and to about 108 per cent of what would be the full moving load on the bridge with that spacing. It increases the sum of the moving and fixed loads by only about 2 per cent, however, so it is evident that no change in the spacing of trolley cars—except such a large one as would seriously interfere with the use of the bridge—can effect any decided increase in the safety of the bridge. The restrictions as to minimum spacing of cars, however, should be strictly enforced.

The above refers only to moving loads affecting the main members of the bridge, as the cables. Those affecting the floor only, such as weights on wheels, have also to be considered. Only in one instance have the wheel loads been increased above those proposed by the designer, this increase being the change in weight from 32 tons to 44 tons of the motor or grip cars using the railroad tracks. It is not known whether the wooden stringers were strengthened when this increase of weight was made, but in either case both these stringers and some other parts of the floor are now under stresses greater than are considered good practice.

Much has been published as to the large weight of extraneous dead load on the bridge in the form of mail tubes, telegraph and telephone cables, etc. We have found no useless dead load on the bridge and the combined weight of mail tubes and telegraph and telephone wires is only 1.5 per cent of the total moving and dead load.

It is evident that of the three causes just described only one—the increase in the moving load—has had any serious effect in decreasing the safety of the bridge. This loss of safety could, of course, be recovered by reducing the moving loads to their former amounts, but to do this would reduce the usefulness of the bridge very greatly and should not be considered except as a very temporary arrangement or a last desperate expedient. Because of certain unperceived defects in the original design, however, the bridge has never actually been as strong or as safe as it was believed to be. These defects are of such a nature that, although serious in their effect, they can be remedied in a comparatively short time and at a comparatively small cost. It is believed, also, that when these defects are removed the bridge will not only be safe under its present loads, but that these loads may even be safely increased. The safety of the bridge, therefore, should be increased by remedying the defects in the design.

DEFECTS IN THE ORIGINAL DESIGN.—In considering the defects of the design it should be borne in mind that this bridge was designed over twenty years ago, when steel as a material for bridges was just coming into use. The science of bridge designing was then very much cruder than now and very little attention was paid to secondary stresses. It is difficult at the present day, even by an effort, to realize the changes which have occurred since that time in the point of view. Many of the features which now seem self-evident errors have been realized as such only from the lessons taught by their use in early bridges. We therefore hope that our criticisms will be accepted as referring to the design, not to the designer. Our effort has been to measure the structure as it now stands, irrespective of its origin or the conditions under which it was designed, by the standards of the best present practice in bridge design.

Before mentioning the principal defects in design which act to lessen the safety of the bridge, we wish to point out that the computations on which our conclusions are based are in many respects necessarily incomplete and inexact. The lack of adequate plans of the bridge is such that a complete survey of the structure would be necessary in order to obtain a full and reliable knowledge of its members. Such a survey would alone take more time than that allowed for our entire investigation. We have made no investigation of the stresses caused by wind, as the lack of plans and the lack of time were each in themselves sufficient to prevent our doing so. The same statement will apply to all stresses in the end spans. We have therefore confined our investigation to the main span, where the observed failures occurred, and to its action under vertical loads only. The time allowed us was barely sufficient for even this, as the structure is a very complicated one, resisting either vertical or horizontal forces by means of three combined systems, and required the development of many special original formulæ for its calculation. Many of the details of this bridge are entirely different from those of ordinary bridges and need careful study. A much more extensive investigation would be necessary before it would be possible to point out all the defective parts that must be improved before the bridge can be made as safe as is now considered good practice.

Our investigation has, however, been both complete enough and exact enough for us to state conclusively that the bridge does not conform to the usual standards of safety; that improvements increasing its safety are imperative, and that such improvements can be made at a comparatively moderate cost and without materially interfering with traffic. The principal defects of design observed as causing a decrease in the safety will now be mentioned.

(To be continued.)

MOUNTING PHOTOGRAPHS.

To mount photographs of, say, whole-plate size and upward without the finished result creating despair in the heart of the operator from the amount of cockling is a consummation often attempted but seldom achieved. Solutions having this end in view are plentifully strewn along the path of the photographer, and should make his life a bed of roses if their performance was equal to their promise, which is seldom the case. The portrait man who confines his mounting to cartes-de-visite and cabinets is seldom disturbed by this evil, as the subsequent operation of burnishing compels the cards to assume an even surface. The evil is most felt by the photographer whose business necessitates the use of mounts not amenable to the coercive treatment of the rolling press, and pre-eminently by anyone who has the mounting of photographs on thin supports, for insertion in reports and works of a similar character.

Mountants in which the greater part of the necessary water has been replaced by methylated spirit have been suggested as a remedy; but, while they lessen the evil, they do not entirely remove it. If buckling of the mount is to be cured, the prints must be mounted in a dry state, and the film of mountant borne by the print must be just sufficient to attach it firmly to the mount and no more. The great virtue of the method here described consists of the marvelously thin film of tenacious mountant applied to the print in its dry condition, shrinkage by this means being entirely obviated. A drawing-board with a perfectly smooth surface and of fair dimensions, an ivory or bone burnisher attached to a short handle, with some common glue, are the principal requisites. Take, say, a quarter of a pound of the glue broken into small pieces and cover it with water in a clean gallipot, large enough to allow for the subsequent swelling of the glue. Place on one side until the glue has become thoroughly permeated by the water, then pour off the excess and dissolve the glue in the water it has absorbed, by placing the gallipot in a vessel of hot water. The solution tested with a piece of blue litmus paper will show a distinctly acid reaction, which must be carefully neutralized by adding some solution of carbonate of soda. The amount of water absorbed by the glue will probably be too little to give it the best working consistency, and, if this is the case, sufficient should be added to make it about the thickness of ordinary molasses. Careful filtration through a cambric handkerchief, and the addition of about ten grains of thymol, completes the preparation of the mounting solution. As glue deteriorates by frequent and prolonged heating, it is preferable to make up a stock solution, from which sufficient for the work in hand can be taken in the form of jelly, melted, and used up right away.

The finished prints, dried and trimmed to the required size, are placed on the boards they are to occupy when mounted, and, as it is impossible to remove a print for readjustment once it is laid down for final mounting, the wisest course is to indicate by light pencil marks on the mount the exact position the print is to occupy; then it may be laid down accurately and without any indecision. A small gas or oil stove is required on the mounting table to keep the glue liquid, but maintaining the solution in a constant state of ebullition throughout the operation is unnecessary and harmful to the glue; the flame should be regulated so that the mountant is kept just at the melting point. Place the drawing-board beside the gas stove, and with a house-painter's brush of good quality and size spread the glue over an area considerably exceeding the dimensions of the print to be mounted. A thin coating of glue evenly applied to the board is the end to aim at, to accomplish which the brush should be worked in horizontal strokes, crossing these with others at right angles. Have at hand a small pile of paper cut into pieces somewhat larger than the print to be mounted (old newspaper answers admirably for these pieces), lay one down on the glued patch and press it well into contact by passing the closed hand across it in all directions. Raise one corner of the paper, and slowly but firmly strip it from the board. Repeat the operations of gluing the board (in the same place) and stripping the newspaper two or three times, when a beautifully even cushion of glue will remain on the board.

Mounting the prints is the next step. The cushion of glue obtained on the board has to be coated with glue for, say, every second print, but the amount applied must be as small as possible. After applying the glue the print is laid down upon it, a square of the waste newspaper laid over the print, which has then to be rubbed well into contact with the glue. Raise a corner of the print with the point of a penknife and strip it from the board, as in the case of the newspaper. Care must be taken when handling the print in its glued condition to keep the fingers well beyond the edges of the print, in order that no glue may be abstracted from the edges. Lay the print quickly down upon its mount; with a clean, soft linen duster smooth it everywhere into contact, place upon it a square of photographic drying-board, and with the bone burnisher go over it in all directions, using considerable pressure. The finished result is a mounted print that shows no signs of buckling, and which adheres to the mount with perfect tenacity.—G. T. Harris, in British Journal of Photography.

GERMAN FIRE-ENGINES.

We present herewith several illustrations of German fire-engines taken from Glaser's Annalen, which may be of some interest to our readers.

In order to meet the requirements of compactness, ability to raise steam in a short time and in large volumes, a Hamburg firm has placed upon the market the engine shown in Figs. 1 and 2. In the first boiler all seams are welded. In the second boiler, on the other hand, the cover of the firebox and of the boiler jacket are riveted in place. The extension of the firebox to form the smoke-flue, as well as the welding together of the boiler jacket and the firebox at the door opening of the firebox, in both of these constructions, leads one to infer that only the very best material can be used. The water-tubes are made of copper or steel and are arranged crosswise and obliquely. Forced draft is used. The grate is so arranged that it can be easily taken apart and removed through the firebox-door. The grate consists of four cast-steel segments which when arranged in the firebox form a square hole. This opening is filled with grate bars made of particularly refractory material. Owing to this disposition of the parts it is possible to remove the central portion of the grate and renew it at a slight expense. Beneath the grate is a wrought-iron ash-receiver which can be raised or lowered by the stoker. The boiler consists of three independent feeders, comprising respectively a power pump, an injector, and a hand pump; two gage glasses; one double gage (for the stoker and the engineer); one steam cut-off valve; two safety valves, one exhaust-valve, and one steam-whistle.

The feeders supply water from a tank situated behind the boiler, which tank can be filled either by hand or by means of the power pump. The steam cut-off valve is arranged at one side of the boiler with its hand-wheel within convenient reach of the engineer, who stands upon the right side. By opening the exhaust-valve the pressure can be rapidly lowered. A hose can be coupled to the exhaust-valve, so that the tubes of the boiler can be quickly cleaned.

Fig. 1.

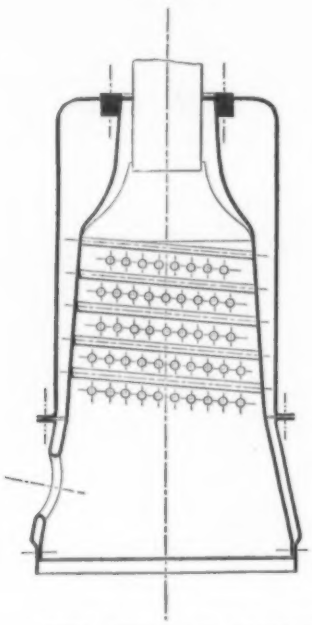
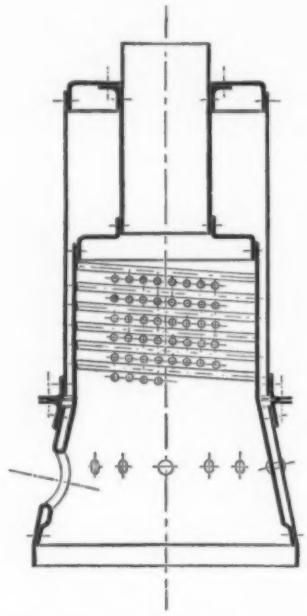


Fig. 2.



TWO TYPES OF GERMAN FIRE-ENGINE BOILERS.

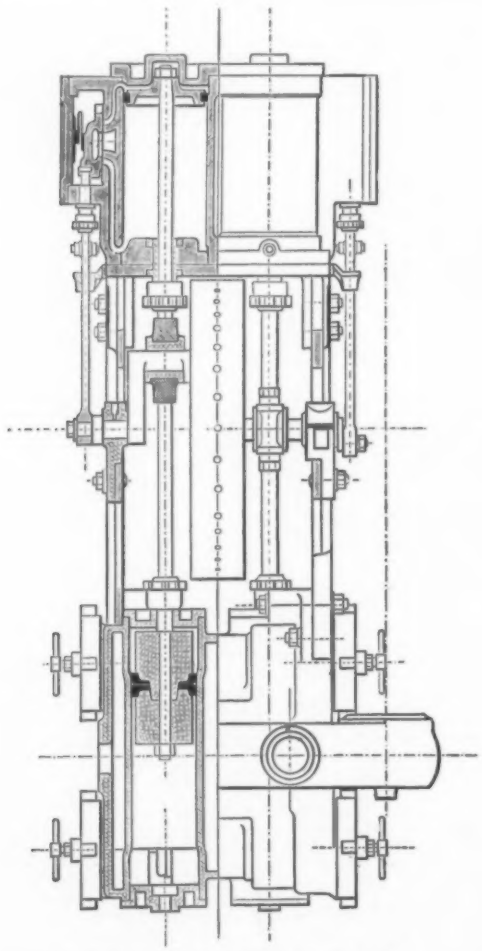


Fig. 3.—PLAN VIEW OF A GERMAN FIRE-ENGINE PUMP.

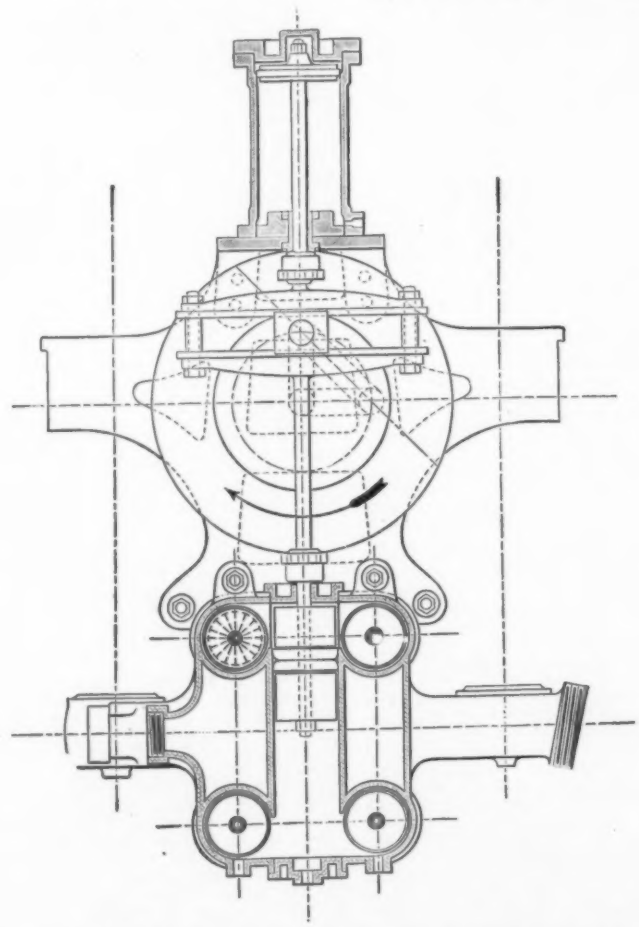


Fig. 4.—PARTIAL VERTICAL SECTION OF A GERMAN FIRE-ENGINE PUMP.

The pump is of the two-cylinder type, as a general rule. But larger engines have been built with three cylinders. A pump of the first type is shown in Figs. 3 and 4.

The two steam cylinders are constructed so that the slide-valve coverings are situated on the outside. The cylinders are cast in one piece. The pump body is composed of phosphor-bronze cast in one piece together with the valve seats. Since the suction and pressure valves are screwed upon a common bolt they can be easily removed, simply by disconnecting a bayonet joint. In order to secure uniform operation, the suction and pressure chambers have been made as large as possible. Both are provided with pressure and vacuum gages. The suction connection is located on the left of the wagon; the pressure connection is located on the right. To prevent too great a tension of the hose an automatic valve is interposed between the suction and pressure chambers. By means of this valve the superfluous water is conducted to the suction-chamber.

The movement of the steam-engine piston is directly transmitted to the pump-piston; and the common piston-rod is connected with a link by which the crank-shaft is turned. From this shaft not only the steering mechanism, but also the feeder-pump and the lubricating-pump are driven. Between the two pistons the shaft carries a two-piece flywheel and is mounted in two bearings in a cast-steel frame, which serve to connect the steam-cylinder with the pump body and to sustain the entire pumping mechanism. The same description would apply to the engine shown in Figs. 5 and 6, which has a normal efficiency of 1,500 liters per minute. The weight of this engine is about 2,600 kilogrammes. The boiler is constructed in the manner indicated in Fig. 1, and has a heating surface of 7.6 square meters and operates at a pressure of 8 atmospheres.

In the engine shown in Figs. 7 and 8 the pump mechanism is not carried between the front trunk of the wagon and the boiler, but behind the latter. The rear axle must, therefore, sustain a considerable load; but it cannot be denied that the engine and boiler can be better inspected and more conveniently served. Since the boiler must be served from the side, and since it may be necessary to add more fuel while the entire vehicle is in motion, the boiler is provided at its rearmost side, beneath the pump mechanism, with an auxiliary and somewhat smaller firebox-door. By shifting the position of the steam pump the parts which we have previously described must of necessity change their position by ninety degrees, so that the suction and pressure connections are now located in the rear.

The engine pictured is intended to throw 2,200 liters of water a minute, and weighs about 3,000 kilogrammes. The heating surface of the boiler is in this instance 8.6 square meters.

In order to attain higher efficiencies, the firm in question has constructed steam-engines with three cylinders with cranks set 120 degrees apart. The slide-valve coverings of the steam cylinder are located on one side, whereas the remaining valves, which, by reason of the three cylinders, can no longer be placed at both sides of the pump body, are inclosed in a common chest at one side of the pump. The cover screwed to the valve-chest has three openings for the ready inspection and removal of the valve-seats. In the three-cylinder engine the flywheel is dispensed with.

Attempts have recently been made to employ triple-expansion engines, having one high-pressure and two low-pressure cylinders. In these engines the boiler pressure is 15 atmospheres. Steam pumps of this type throw 4,000 liters of water per minute and are chiefly used in harbors.

[Continued from SUPPLEMENT, No. 1345, page 21562.]

THE BRITISH ASSOCIATION AT GLASGOW.*

THE COARSE-GRAINEDNESS OF MATTER.

MATTER in bulk appears to be continuous. Such substances as water or air appear to the ordinary observer to be perfectly uniform in all their properties and qualities, in all their parts.

The hasty conclusion that these bodies are really uniform is, nevertheless, unthinkable.

In the first place, the phenomena of diffusion afford conclusive proof that matter when apparently quiescent is in fact in a state of internal commotion. I need not recapitulate the familiar evidence to prove that gases and many liquids when placed in communication interpenetrate or diffuse into each other; or that air, in contact with the surface of water, gradually becomes laden with water vapor, while the atmospheric gases in turn mingle with the water. Such phenomena are not exhibited by liquids and gases alone, or by solids at high temperatures only. Sir W. Roberts Austen has placed pieces of gold and lead in contact at a temperature of 18 deg. C. After four years the gold had traveled into the lead to such an extent that not only were the two metals united, but, on analysis, appreciable quantities of the gold were detected even at a distance of more than 5 millimeters from the common surface, while within a distance of three-quarters of a millimeter from the surface gold had penetrated into the lead to the extent of 1 ounce 6 pennyweights per ton, an amount which could have been profitably extracted.

Whether it is or is not possible to devise any other intelligible account of the cause of such phenomena, it is certain that a simple and adequate explanation is found in the hypothesis that matter consists of discrete parts in a state of motion, which can penetrate into the spaces between the corresponding parts of surrounding bodies.

The hypothesis thus framed is also the only one which affords a rational explanation of other simple and well-known facts. If matter is regarded as a continuous medium, the phenomena of expansion are unintelligible. There is, apparently, no limit to the expansion of matter, or, to fix our attention on one kind of matter, let us say to the expansion of a gas; but it is inconceivable that a continuous material which fills or is present in every part of a given space could also be present in every part of a space a million times as great. Such a statement might be made of a mathematical abstraction; it cannot be true of any real substance or thing. If, however, matter consists of discrete particles, separated from each other either by empty space or by something different from themselves, we can at once understand that expansion and contraction may be nothing more than the mutual separation or approach of these particles.

Again, no clear mental picture can be formed of the phenomena of heat unless we suppose that heat is a mode of motion. In the words of Rumford, it is "extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in (his) experiment (on friction) except it be motion" (Phil. Trans., 1798, p. 99). And if heat be motion there can be no doubt that it is the fundamental particles of matter which are moving, for the motion is not visible, is not motion of the body as a whole, while diffusion, which is a movement of matter, goes on more quickly as the temperature rises, thereby proving that the internal motions have become more rapid, which is exactly the result which would follow if these were the movements which constitute sensible heat.

Combining, then, the phenomena of diffusion, expansion, and heat, it is not too much to say that no hypotheses which make them intelligible have ever been framed other than those which are at the basis of the atomic theory.

Many other considerations also point to the same conclusion. Many years ago Lord Kelvin gave independent arguments, based on the properties of gases, on the constitution of the surfaces of liquids, and on the electric properties of metals, all of which indicate that matter is, to use his own phrase, coarse-grained—that it is not identical in constitution throughout, but that adjacent minute parts are distinguishable from each other by being either of different natures or in different states.

And here it is necessary to insist that all these fundamental proofs are independent of the nature of the particles or granules into which matter must be divided.

The particles, for instance, need not be different in kind from the medium which surrounds and separates them. It would suffice if they were what may be called singular parts of the medium itself, differing from the rest only in some peculiar state of internal motion or of distortion, or by being in some other way earmarked as distinct individuals. The view that the constitution of matter is atomic may and does receive support from theories in which definite assumptions are made as to the constitution of the atoms; but when, as is often the case, these assumptions introduce new and more recondite difficulties, it must be remembered that the fundamental hypothesis—that matter consists of discrete parts, capable of independent motions—is forced upon us by facts and arguments which are altogether independent of what the nature and properties of these separate parts may be.

As a matter of history, the two theories, which are not by any means mutually exclusive, that atoms are particles which can be treated as distinct in kind from the medium which surrounds them, and that they are parts of that medium existing in a special state, have both played a large part in the theoretical development of the atomic hypothesis. The atoms of Waterston, Clausius, and Maxwell were particles. The vortex-atoms of Lord Kelvin, and the strain-atoms (if I may call them so) suggested by Mr. Larmor, are states of a primary medium which constitutes a physical connection between them, and through which their mutual actions arise and are transmitted.

PROPERTIES OF THE BASIS OF MATTER.

It is easy to show that, whichever alternative be adopted, we are dealing with something, whether we consider it under the guise of separate particles or of differentiated portions of the medium, which has properties different from those of matter in bulk.

For if the basis of matter had the same constitution as matter, the irregular heat movements could hardly be maintained either against the viscosity of the medium or the frittering away of energy of motion which would occur during the collisions between the particles. Thus, even in the case in which a hot body is prevented from losing heat to surrounding objects, its sensible heat should spontaneously decay by a process of self-cooling. No such phenomenon is known, and though on this, as on all other points, the limits of our knowledge are fixed by the uncertainty of experiment, we are compelled to admit that, to all appearance, the fundamental medium, if it exists, is unlike a material medium, in that it is non-viscous; and that the particles, if they exist, are so constituted

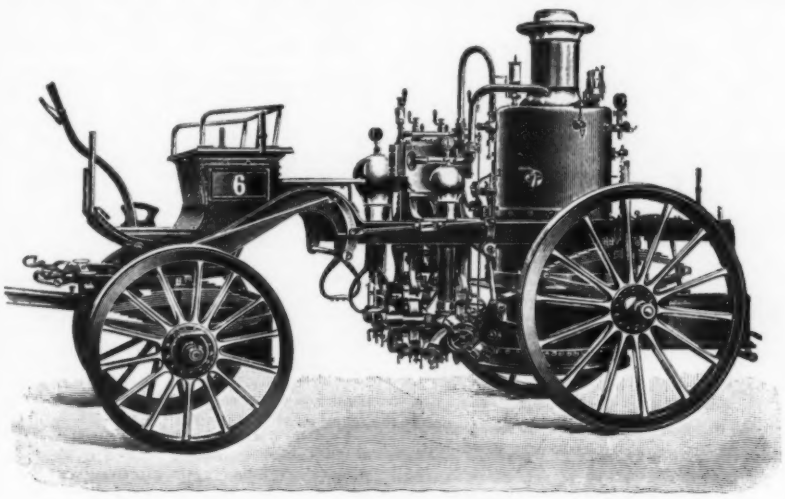


FIG. 5.

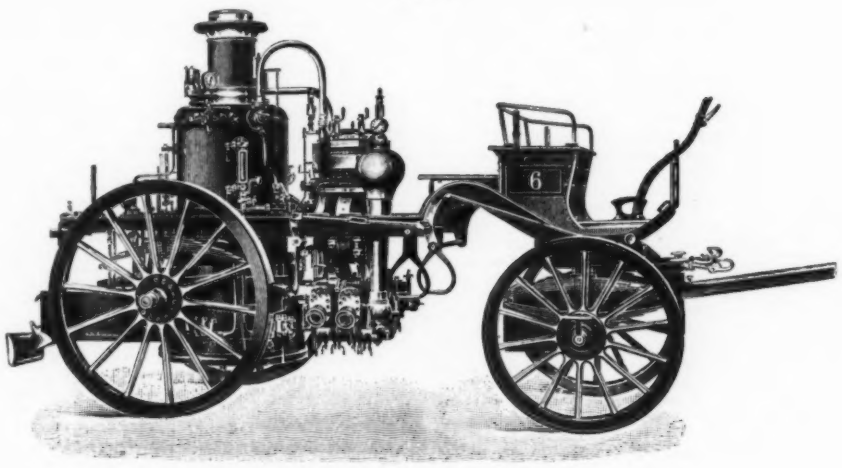


FIG. 6.

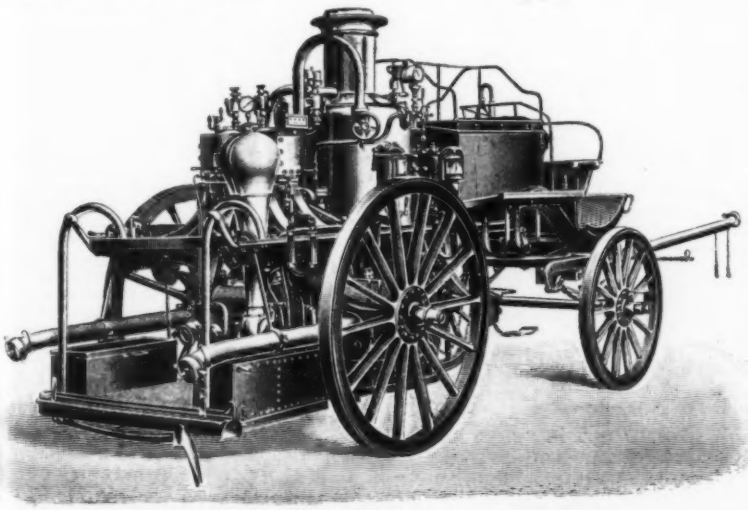


FIG. 7.

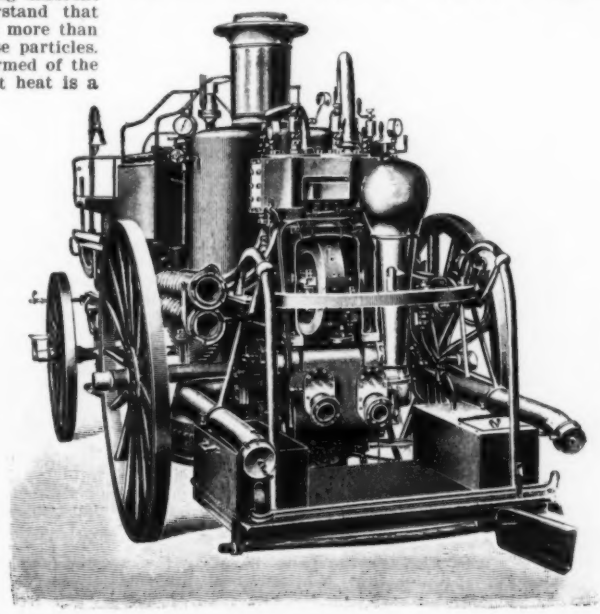


FIG. 8.

TYPICAL EXAMPLES OF IMPROVED GERMAN FIRE-ENGINES.

* Inaugural Address by Prof. Arthur W. Rücker, M.A., LL.D., D.Sc., Sec. R.S., President of the Association.

that energy is not frittered away when they collide. In either case, we are dealing with something different from matter itself in the sense that, though it is the basis of matter, it is not identical in all its properties with matter.

The idea therefore that entities exist possessing properties different from those of matter in bulk is not introduced at the end of a long and recondite investigation to explain facts with which none but experts are acquainted. It is forced upon us at the very threshold of our study of nature. Either the properties of matter in bulk cannot be referred to any simpler structure, or that simpler structure must have properties different from those of matter in bulk as we directly knew it—properties which can only be inferred from the results which they produce.

No *a priori* argument against the possibility of our discovering the existence of quasi-material substances, which are nevertheless different from matter, can prove a negative proposition that such substances cannot exist. It is not a self-evident truth that no substance other than ordinary matter can have an existence as real as that of matter itself. It is not axiomatic that matter cannot be composed of parts whose properties are different from those of the whole. To assert that even if such substances and such parts exist no evidence however cogent could convince us of their existence is to beg the whole question at issue; to decide the cause before it has been heard.

We must therefore adhere to the standpoint adopted by most scientific men, viz., that the question of the existence of ultra-physical entities, such as atoms and the ether, is to be settled by the evidence, and must not be ruled out as inadmissible on *a priori* grounds.

On the other hand, it is impossible to deny that, if the mere entry on the search for the concealed causes of physical phenomena is not a trespass on ground we have no right to explore, it is at all events the beginning of a dangerous journey.

The wraiths of phlogiston, caloric, luminiferous corpuscles, and a crowd of other phantoms haunt the investigator, and as the grim host vanishes into nothingness he cannot but wonder if his own conceptions of atoms and of the ether

> "shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a wrack behind."

But though science, like Bunyan's hero, has sometimes had to pass through the "Valley of Humiliation," the specters which meet it there are not really dangerous if they are boldly faced. The facts that mistakes have been made, that theories have been propounded, and for a time accepted, which later investigations have disproved, do not necessarily discredit the method adopted. In scientific theories, as in the world around us, there is a survival of the fittest, and Dr. James Ward's unsympathetic account of the blunders of those whose work, after all, has shed glory on the nineteenth century, might *mutatis mutandis* stand for a description of the history of the advance of civilization. "The story of the progress so far," he tells us, "is briefly this: Divergence between theory and fact one part of the way, the wreckage of abandoned fictions for the rest, and an unattainable goal of phenomenal nihilism and ultra-physical mechanism beyond" ("Naturalism and Agnosticism," vol. i., p. 153).

"The path of progress," says Prof. Karl Pearson, "is strewn with the wreck of nations. Traces are everywhere to be seen of the hecatombs of inferior races, and of victims who found not the narrow way to the greater perfection. Yet these dead peoples are, in very truth, the stepping-stones on which mankind has arisen to the higher intellectual and deeper emotional life of to-day." ("National Life from the Standpoint of Science," p. 62).

It is only necessary to add that the progress of society is directed toward an unattainable goal of universal contentment, to make the parallel complete.

And so, in the one case as in the other, we may leave "the dead to bury their dead." The question before us is not whether we too may not be trusting to false ideas, erroneous experiments, evanescent theories. No doubt we are; but, without making an insolent claim to be better than our fathers, we may fairly contend that, amid much that is uncertain and temporary, some of the fundamental conceptions, some of the root-ideas of science, are so grounded on reason and fact that we cannot but regard them as an aspect of the very truth.

Enough has, perhaps, now been said on this point for my immediate purpose. The argument as to the constitution of matter could be developed further in the manner I have hitherto adopted, viz., by series of propositions, the proof of each of which is based upon a few crucial phenomena. In particular, if matter is divided into moving granules or particles, the phenomenon of cohesion proves that there must be mutual actions between them analogous to those which take place between large masses of matter, and which we ascribe to force, thereby indicating the regular, unvarying operation of active machinery which we have not yet the means of adequately understanding. For the moment, I do not wish to extend the line of reasoning that has been followed. My main object is to show that the notion of the existence of ultra-physical entities and the leading outlines of the atomic theory are forced upon us at the beginning of our study of nature, not only by *a priori* considerations, but in the attempt to comprehend the results of even the simplest observations. These outlines cannot be effaced by the difficulties which undoubtedly arise in filling up the picture. The cogency of the proof that matter is coarse-grained is in no way affected by the fact that we may have grave doubts as to the nature of the granules. Nay, it is of the first importance to recognize that, though the fundamental assumptions of the atomic theory receive overwhelming support from a number of more detailed arguments, they are themselves almost of the nature of axioms, in that the simplest phenomena are unintelligible if they are abandoned.

THE RANGE OF THE ATOMIC THEORY.

It would be most unfair, however, to the atomic theory to represent it as depending on one line of reasoning only, or to treat its evidence as bounded by the very general propositions I have discussed.

It is true that as the range of the theory is extended the fundamental conception that matter is granular must be expanded and filled in by supplementary hypotheses as to the constitution of the granules. It may also be admitted that no complete or wholly satisfactory description of that constitution can as yet be given; that perfection has not yet been attained here or in any other branch of science; but the number of facts which can be accounted for by the theory is very large compared with the number of additional hypotheses which are introduced; and the cumulative weight of the additional evidence obtained by the study of details is such as to add greatly to the strength of the conviction that, in its leading outlines, the theory is true.

It was originally suggested by the facts of chemistry, and though, as we have seen, a school of chemists now thrusts it into the background, it is none the less true, in the words of Dr. Thorpe, that "every great advance in chemical knowledge during the last ninety years finds its interpretation in [Dalton's] theory" ("Essays on Historical Chemistry," 1894, p. 368).

The principal mechanical and thermal properties of gases have been explained, and in large part discovered, by the aid of the atomic theory; and, though there are outstanding difficulties, they are, for the most part, related to the nature of the atoms and molecules, and do not affect the question as to whether they exist.

The fact that different kinds of light all travel at the same speed in interplanetary space, while they move at different rates in matter, is explained if matter is coarse-grained. But to attempt to sum up all this evidence would be to recite a text-book on physics. It must suffice to say that it is enormous in extent and varied in character, and that the atomic theory imparts a unity to all the physical sciences which has been attained in no other way.

I must, however, give a couple of instances of the wonderful success which has been achieved in the explanation of physical phenomena by the theory we are considering, and I select them because they are in harmony with the line of argument I have been pursuing.

When a piece of iron is magnetized its behavior is different according as the magnetic force applied to it is weak, moderate, or strong. When a certain limit is passed, the iron behaves as a non-magnetic substance to all further additions of magnetic force. With strong forces it does and with very weak forces it does not remain magnetized when the force ceases to act. Prof. Ewing has imitated all the minute details of these complicated properties by an arrangement of small isolated compass needles to represent the molecules. It may fairly be said that as far as this particular set of phenomena is concerned a most instructive working model based on the molecular theory has not only been imagined but constructed.

The next illustration is no less striking. We may liken a crowd of molecules to a fog; but while the fog is admitted by everybody to be made up of separate globules of water, the critics of scientific method are sometimes apt to regard the molecules as mere fictions of the imagination. If, however, we could throw the molecules of a highly rarefied gas into such a state that vapor condensed on them, so that each became the center of a water-drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist, surely no stronger proof of their reality could be desired. Yet there is every reason to believe that something very like this has been accomplished by Mr. C. T. R. Wilson and Prof. J. J. Thomson.

It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water-vapor alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapor condenses on the dust particles, and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei; for if a highly charged body from which electricity is escaping be placed near a steam jet, the steam condenses; and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it.

Again, according to accepted theory, when a current of electricity flows through a gas, some of the atoms are divided into parts which carry positive and negative charges as they move in opposite directions, and unless this breaking-up occurs a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Roentgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionized.

Thus by these two distinct lines of argument we come to the conclusions: First, that the presence of electrified particles promotes the formation of mist, and, second, that in an ionized gas such electrified particles are provided by the breaking-up of atoms.

The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionized air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present, and thus in the cloud we have visible evidence of the presence of the divided atoms. If, then, we cannot handle the individual molecules, we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the center of a discrete particle of a visible fog.

I have purposely chosen this illustration because the explanation is based on a theory—that of ionization—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction; a fact on which the construction of telegraphic instruments is based. Hence if the theory be true a similar effect ought to be produced by a moving charge of electricity. This experiment was tried many years ago in the laboratory of Helmholtz by Rowland, who caused a charged disk to spin rapidly near a magnet. The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland.

M. Crémieu's results are already the subject of controversy,* and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's results were upheld, our views as to electricity would have to be modified, the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalization that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Prof. J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *a priori* probability increased that the different structures which we call elements may all be built of similar bricks, but the discovery by Lenard that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Prof. Thomson to be "a strong confirmation of the view that the atoms of the elementary substances are made up of similar parts, all of which are alike."† On the present occasion, however, we are occupied rather with the foundations than with these ultimate ramifications of the atomic theory; and having shown how wide its range is, I must, to a certain extent, retrace my steps and return to the main line of my argument.

THE PROPERTIES OF ATOMS AND MOLECULES.

For if it be granted that the evidence that matter is coarse-grained and is formed of separate atoms and molecules is too strong to be resisted, it may still be contended that we can know little or nothing of the sizes and properties of the molecules.

It must be admitted that, though the fundamental postulates are always the same, different aspects of the theory, which have not in all cases been successfully combined, have to be developed when it is applied to different problems; but in spite of this there is little doubt that we have some fairly accurate knowledge of molecular motions and magnitudes.

If a liquid is stretched into a very thin film, such as a soap bubble, we should expect indications of a change in its properties when the thickness of the film is not a very large multiple of the average distance between two neighboring molecules. In 1890 Sohncke (Wied. Ann., 1890, xl., pp. 345, 355) detected evidence of such a change in films of the average thickness of 106 millionths of a millimeter ($\mu\mu$), and quite recently Rudolph Weber found it in an oil-film when the thickness was 115 $\mu\mu$ (Annalen der Physik, 1901, iv., pp. 706-721).

Taking the mean of these numbers and combining the results of different variants of the theory, we may conclude that a film should become unstable and tend to rupture spontaneously somewhere between the thicknesses of 110 and 55 $\mu\mu$, and Prof. Reinold and I found by experiment that this instability is actually exhibited between the thicknesses of 96 and 45 $\mu\mu$ (Phil. Trans., 1893, 184, pp. 505-529). There can therefore be little doubt that the first approach to molecular magnitudes is signaled when the thickness of a film is somewhat less than 100 $\mu\mu$, or 4 millionths of an inch.

Thirteen years ago I had the honor of laying before the Chemical Society a résumé of what was then known on these subjects (Chem. Soc. Trans., liii., March, 1888, pp. 222-262), and must refer to that lecture or to the most recent edition of O. E. Meyer's work on the kinetic theory of gases ("Kinetic Theory of Gases," O. E. Meyer, 1899; translated by R. E. Baynes) for the evidence that various independent lines of argument enable us to estimate quantities very much less than 4 millionths of an inch, which is perhaps from 500 to 1,000 times greater than the magnitude which, in the present state of our knowledge, we can best describe as the diameter of a molecule.

Confining our attention, however, to the larger quantities, I will give one example to show how strong is the cumulative force of the evidence as to our knowledge of the magnitudes of molecular quantities.

We have every reason to believe that though the molecules in a gas frequently collide with each other, yet in the case of the more perfect gases the time occupied in collisions is small compared with that in which each molecule travels undisturbed by its fellows. The average distance traveled between two successive encounters is called the mean free path, and, for the reason just given, the question of the magnitude of this distance can be attacked without any precise knowledge of what a molecule is, or of what happens during an encounter.

Thus the mean free path can be determined, by the aid of the theory, either from the viscosity of the gas or from the thermal conductivity. Using figures given in the latest work on the subject (Meyer's "Kinetic Theory of Gases;" see above), and dealing with one gas only, as a fair sample of the rest, the lengths of the mean free path of hydrogen as determined by these two independent methods differ only by about 3 per cent. Further, the mean of the values

* See Phil. Mag., July, 1901, p. 144; and Johns Hopkins University Circulars, xx, No. 152, May-June, 1901, p. 78.

† For the most recent account of this subject see an article on "Bodies Smaller than Atoms," by Prof. J. J. Thomson in the Popular Science Monthly (The Science Press), August, 1901.

which I gave in the lecture already referred to differed only by about 6 per cent from the best modern results, so that no great change has been introduced during the last thirteen years.

It may, however, be argued that these concordant values are all obtained by means of the same theory, and that a common error may affect them all. In particular, some critics have of late been inclined to discredit the atomic theory by pointing out that the strong statements which have sometimes been made as to the equality, among themselves, of atoms or molecules of the same kind may not be justified, as the equality may be that of averages only, and be consistent with a considerable variation in the sizes of individuals.

Allowing this argument more weight than it perhaps deserves, it is easy to show that it cannot affect seriously our knowledge of the length of the mean free path.

Prof. George Darwin (Phil. Trans., 180) has handled the problem of a mixture of unequal spherical bodies in the particular case in which the sizes are distributed according to the law of errors, which would involve far greater inequalities than can occur among atoms. Without discussing the precise details of his problem, it is sufficient to say that in the case considered by him the length of the mean free path is 7-11 of what it would be if the particles were equal. Hence, were the inequalities of atoms as great as in this extreme case, the reduction of the mean free path in hydrogen could only be from 185 to 119 $\mu\mu$; but they must be far less, and therefore the error, if any, due to this cause could not approach this amount. It is probably inappreciable.

Such examples might be multiplied, but the one I have selected is perhaps sufficient to illustrate my point, viz., that considerable and fairly accurate knowledge can be obtained as to molecular quantities by the aid of theories the details of which are provisional, and are admittedly capable of improvement.

IS THE MODEL UNIQUE?

But the argument that a correct result may sometimes be obtained by reasoning on imperfect hypotheses raises the question as to whether another danger may not be imminent. To be satisfactory our model of nature must be unique, and it must be impossible to imagine any other which agrees equally well with the facts of experiment. If a large number of hypotheses could be framed with equal claims to validity, that fact would alone raise grave doubts as to whether it were possible to distinguish between the true and the false. Thus Prof. Poincaré has shown that an infinite number of dynamical explanations can be found for any phenomenon which satisfies certain conditions. But though this consideration warns us against the too ready acceptance of explanations of isolated phenomena, it has no weight against a theory which embraces so vast a number of facts as those included by the atomic theory. It does not follow that, because a number of solutions are all formally dynamical, they are therefore all equally admissible. The pressure of a gas may be explained as the result of a shower of blows delivered by molecules, or by a repulsion between the various parts of a continuous medium. Both solutions are expressed in dynamical language; but one is, and the other is not, compatible with the observed phenomena of expansion. The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive.

On the whole, then, the question as to whether we are attempting to solve a problem which has an infinite number of solutions may be put aside until one solution has been found which is satisfactory in all its details. We are in a sufficient difficulty about that to make the rivalry of a second of the same type very improbable.

THE PHENOMENA OF LIFE.

But it may be asked—nay, it has been asked—may not the type of our theories be radically changed? If this question does not merely imply a certain distrust in our own powers of reasoning, it should be supported by some indication of the kind of change which is conceivable.

Perhaps the chief objection which can be brought against physical theories is that they deal only with the inanimate side of nature, and largely ignore the phenomena of life. It is therefore in this direction, if in any, that a change of type may be expected. I do not propose to enter at length upon so difficult a question, but, however we may explain or explain away the characteristics of life, the argument for the truth of the atomic theory would only be affected if it could be shown that living matter does not possess the thermal and mechanical properties to explain which the atomic theory has been framed. This is so notoriously not the case that there is the gravest doubt whether life can in any way interfere with the action within the organism of the laws of matter in bulk belonging to the domain of mechanics, physics, and chemistry.

Probably the most cautious opinion that could now be expressed on this question is that, in spite of some outstanding difficulties which have recently given rise to what is called Neovitalism, there is no conclusive evidence that living matter can suspend or modify any of the natural laws which would affect it if it were to cease to live. It is possible that though subject to these laws the organism while living may be able to employ, or even to direct, their action within itself for its own benefit, just as it unquestionably does make use of the processes of external nature for its own purposes; but if this be so, the seat of the controlling influence is so withdrawn from view that, on the one hand, its very existence may be denied, while, on the other hand, Prof. Haeckel, following Vogt, has recently asserted that "matter and ether are not dead, and only moved by extrinsic force; but they are endowed with sensation and will; they experience an inclination for condensation, a dislike for strain; they strive after the one and struggle against the other" ("Riddle of the Universe," English translation, 1900, p. 380).

But neither unproved assertions of this kind nor the more refined attempts that have been made by others to bring the phenomena of life and of dead matter under a common formula touch the evidence for the atomic theory. The question as to whether matter consists of elements capable of independent motion is prior to and independent of the further questions as to what these elements are, and whether they are alive or dead.

The physicist, if he keeps to his business, asserts, as the basis of the atomic theory, nothing more than that he who declines to admit that matter consists of separate moving parts must regard many of the simplest phenomena as irreconcilable and unintelligible, in spite of the fact that means of reconciling them are known to everybody, in spite of the fact that the reconciling theory gives a general correlation of an enormous number of phenomena in every branch of science, and that the outstanding difficulties are connected, not so much with the fundamental hypotheses that matter is composed of distinguishable entities which are capable of separate motions as with the much more difficult problem of what these entities are.

On these grounds the physicist may believe that, though he cannot handle or see them, the atoms and molecules are as real as the ice crystals in a cirrus cloud which he cannot reach; as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which sweep past us, unentangled, in the night.

If the confidence that his methods are weapons with which he can fight his way to the truth were taken from the scientific explorer, the paralysis which overcomes those who believe that they are engaged in a hopeless task would fall upon him.

Physiology has specially flourished since physiologists have believed that it is possible to master the physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of the vital force. To supporters of that doctrine the principle of life was not a hidden directing power which could perhaps whisper an order that the floodgates of reservoirs of energy should now be opened and now closed, and could, at the most, work only under immutable conditions to which the living and the dead must alike submit. On the contrary, their vital force pervaded the organism in all its parts. It was an active and energetic opponent of the laws of physics and chemistry. It maintained its own existence not by obeying but by defying them; and though destined to be finally overcome in the separate campaigns of which each individual living creature is the scene, yet like some guerrilla chieftain it was defeated here only to reappear there with unabated confidence and apparently undiminished force.

This attitude of mind checked the advance of knowledge. Difficulty could be evaded by a verbal formula of explanation which in fact explained nothing. If the mechanical, or physical, or chemical causes of a phenomenon did not lie obviously upon the surface, the investigator was tempted to forego the toil of searching for them below; it was easier to say that the vital force was the cause of the discrepancy, and that it was hopeless to attempt to account for the action of a principle which was incomprehensible in its nature.

For the physicist the danger is no less serious, though it lies in a somewhat different direction. At present he is checked in his theories by the necessity of making them agree with a comparatively small number of fundamental hypotheses. If this check were removed, his fancy might run riot in the wildest speculations, which would be held to be legitimate if only they led to formulæ in harmony with facts. But the very habit of regarding the end as everything, and the means by which it was attained as unimportant, would prevent the discovery of those fragments of truth which can only be uncovered by the painful process of trying to make inconsistent theories agree, and using all facts, however remote, as the tests of our central generalization.

"Science," said Helmholtz, "science, whose very object it is to comprehend nature, must start with the assumption that nature is comprehensible." And, again, "The first principle of the investigator of nature is to assume that nature is intelligible to us, since otherwise it would be foolish to attempt the investigation at all." These axioms do not assume that all the secrets of the universe will ultimately be laid bare, but that a search for them is hopeless if we undertake the quest with the conviction that it will be in vain. As applied to life, they do not deny that in living matter something may be hidden which neither physics nor chemistry can explain, but they assert that the action of physical and chemical forces in living bodies can never be understood, if at every difficulty and at every check in our investigations we desist from further attempts in the belief that the laws of physics and chemistry have been interfered with by an incomprehensible vital force. As applied to physics and chemistry, they do not mean that all the phenomena of life and death will ultimately be included in some simple and self-sufficing mechanical theory: they do mean that we are not to sit down contented with paradoxes such as that the same thing can fill both a large space and a little one; that matter can act where it is not, and the like, if by some reasonable hypothesis, capable of being tested by experiments, we can avoid the acceptance of these absurdities. Something will have been gained if the more obvious difficulties are removed, even if we have to admit that in the background there is much that we cannot grasp.

THE LIMIT OF PHYSICAL THEORIES.

And this brings me to my last point. It is a mistake to treat physical theories in general, and the atomic theory in particular, as though they were parts of a scheme which has failed if it leaves anything unexplained, which must be carried on indefinitely on exactly the same principles, whether the ultimate results are, or are not, repugnant to common sense.

Physical theories begin at the surface with phenomena which directly affect our senses. When they are used in the attempt to penetrate deeper into the secrets of nature, it is more than probable that they will meet with insuperable barriers, but this fact does not demonstrate that the fundamental assumptions are false, and the question as to whether any particular obstacle will be forever insuperable can rarely be answered with certainty.

Those who belittle the ideas which have of late governed the advance of scientific theory too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, or that, on the other hand, a mechanical theory of the atoms and of the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities.

For my own part I believe that there is a *via media*.

A man peering into a darkened room, and describing what he thinks he sees, may be right as to the general outline of the objects he discerns, wrong as to their nature and their precise forms. In his description fact and fancy may be blended, and it may be difficult to say where the one ends and the other begins; but even the fancies will not be worthless if they are based on a fragment of truth, which will prevent the explorer from walking into a looking glass or stumbling over the furniture. He who saw "men as trees walking" had at least a perception of the fundamental fact that something was in motion around him.

And so, at the beginning of the twentieth century, we are neither forced to abandon the claim to have penetrated below the surface of nature, nor have we, with all our searching, torn the veil of mystery from the world around us.

The range of our speculations is limited both in space and time: in space, for we have no right to claim, as is sometimes done, a knowledge of the "infinite universe;" in time, for the cumulative effects of actions which might pass undetected in the short span of years of which we have knowledge, may, if continued long enough, modify our most profound generalizations. If some such theory as the vortex-atom theory were true, the faintest trace of viscosity in the primordial medium would ultimately destroy matter of every kind. It is thus a duty to state what we believe we know in the most cautious terms, but it is equally a duty not to yield to mere vague doubts as to whether we can know anything.

If no other conception of matter is possible than that it consists of distinct physical units—and no other conception has been formulated which does not blur what are otherwise clear and definite outlines—if it is certain, as it is, that vibrations travel through space which cannot be propagated by matter, the two foundations of physical theory are well and truly laid. It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist; but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities.

FALL OF A 30-TON ARMATURE INTO SHEFFIELD CANAL.

SCENES of an unusual kind have recently been witnessed at the Sheffield and South Yorkshire Navigation Company's canal wharf, off Wharf Street, Sheffield, through attempts to raise a heavy piece of machinery. The load to be lifted consisted of an armature for a new electrical engine which is in process of construction at the power station of the Sheffield Corporation Tramways. The electric equipment is being supplied by the British Thomson-Houston Company, and the armature was manufactured at that company's works at Berlin and shipped to Goole. Built ready for fitting, it is inclosed in a wooden case covered with felt and measuring 13 feet 6 inches high, 13 feet long, and 10 feet 6 inches wide, and weighing 29 tons 12½ hundredweight. Lowness of bridges and County Council regulations prevented the case being conveyed from Goole to Sheffield by rail or road, and it was handed over to the Goole and Sheffield Transport Company, who took it to Sheffield by the canal. On arrival at Sheffield the difficulties began. At Goole the immense case was easily lifted by means of a 50-ton crane, but at Sheffield wharf the strongest crane on the premises is only calculated to lift five tons. This resulted in elaborate preparations having to be made for the rigging up of a temporary lifting apparatus. Close to the edge of the wharf were erected two immense baulks of timber some 45 feet high and 18 inches square. To the head of each was attached a pulley block suspended from a massive hook, and wire ropes an inch thick ran through the blocks. In one direction they met in a tackle, to which was attached another hook, and the latter was fixed to the package to be lifted, the boat being drawn up to the side of the wharf. In the other direction the ropes ran down nearly to the ground, and through more pulley-blocks on to the drums of two powerful plowing engines. The plan was to exert the power of the engines—which were stationary—upon the wire ropes, and so raise the armature.

On the 14th instant an attempt was made to raise the load. The case was quickly raised about 3 feet, and another foot would have cleared the boat, but the hook supporting the pulley-block at the top of one of the poles snapped across the middle, although it had previously been tested to a weight of 36 tons. Down fell the block, and the power of one of the engines being rendered useless, the whole weight of the load thrown on the other pole proved too much, one of the guy ropes was wrenched from its place, and armature and case fell.

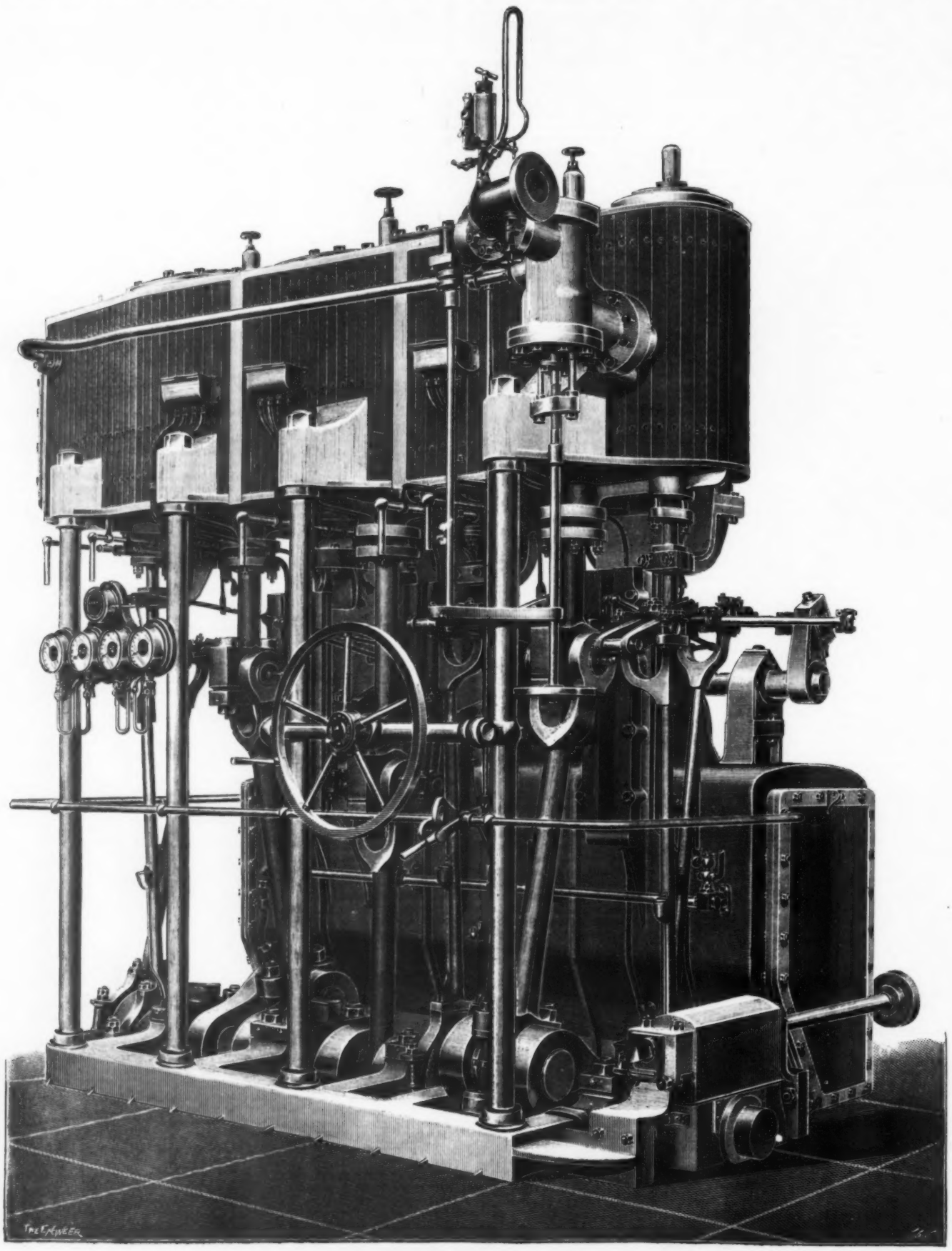
Another attempt was made on the 15th. In place of the hook which gave way the previous day, a strong shackle was fixed. The case was almost on a level with the combings of the boat, when some of the guy ropes, the breaking strain of which had been calculated at 90 tons, gave way. The poles which they supported toppled over and fell into the canal, the blocks for pulling going with them, and the great load,

free from all control, fell, catching the side of the boat furthest away from the wharf side, turning the boat almost completely over, finally settling down in the bed of the basin, the side of the boat being under the load. The vessel is "listed" at an angle of 45 deg., only 2 feet or 3 feet of the case being above water, and in this position the case lay on the 21st instant, pending preparations for another attempt.—The Engineer.

STEAM ENGINES AT THE GLASGOW EXHIBITION.

AMONG the larger vertical steam engines exhibited, that shown by Ross & Duncan occupies a prominent position in the center of the hall. In the same stand they also show a small vertical engine. Neither has steam led to it, but the large engine is moved round by an electric motor and worm gear.

It is triple-expansion surface-condensing, with valve gear of link motion type. The sizes of the cylinders are: high-pressure 12 inches, intermediate-pressure 19½ inches, and low-pressure 32 inches diameter, with a stroke of 24 inches. The high-pressure valve is of the piston type, fitted with solid rings. Steam is admitted in the middle of the valve, and it exhausts top and bottom, so that the casing and the stuffing-box is only subject to the pressure of the intermediate receiver. The top part of the valve is larger in diameter than the bottom part, thus balancing the weight of the valve and its spindle, etc. The intermediate-pressure and low-pressure valves are of the single-ported D form, fitted with springs at back. The pistons are of box section, with springs of Ramsbottom type fitting into the carrier ring, so that each spring can be withdrawn without disturbing the piston. The piston-rods are fitted with oil trays fixed to the bottom of the glands and connected by a pipe to cylinder oil boxes. The connecting-rods are extra long, 54 inches between centers, to ensure smooth running. The reversing shaft is placed behind the engines, leaving the front perfectly open, and giving easy access to the working parts. The arms are of cast steel, and are each fitted with slot and screw, so that the cut-off may be varied in each cylinder separately. The engines are reversed by hand wheel acting by means of a square-threaded screw in a brass nut fitted to the end of main wiper. The sole plate is of box section. It carries five gun-metal main bearings of large surface, fitted into square recesses and held down by wrought iron covers. The crank shaft is built up and forged of ingot steel. The condenser is of cast iron with brass tubes, and runs the whole length of the engine. A galvanized baffle plate is fitted under the exhaust pipe from the low-pressure cylinder to distribute steam well over the tubes. A relief valve held down by atmospheric pressure only is fitted to the bottom of the condenser. The back columns are cast on top of the condenser and carry the cross-head guides. The front columns are four in number, of turned and polished wrought iron. The air, circulating, feed, and bilge pumps, are worked by levers from crosshead of intermediate-pressure engine. The air pump is fitted with foot, bucket and head valves of Thomson's patent metallic type. The chamber, valves, and valve seats are of brass, and the rod of Muntz metal. The circulating pump is double-acting, with fiber valves, chamber and valve seats of brass, and rod of Muntz metal. A double gland cock is fitted to give steam direct to low-pressure casing to facilitate starting. Drain cocks are fitted to the bottom of each cylinder and receiver, with handles brought out to front of engine easily got at from starting platform. All starting handles are brought down close to the reversing wheel, so as to be in immediate control of the man in charge.—For our



TRIPLE-EXPANSION SURFACE CONDENSING ENGINE.

engravings and the foregoing particulars we are indebted to The Engineer.

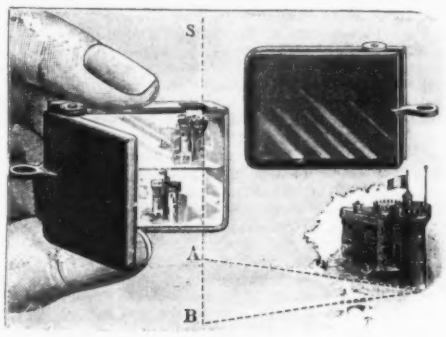
PIG-IRON CASTING MACHINE.

IN a recent number of Stahl und Eisen, says The Iron and Coal Trades Review, Mr. E. Belani shows a suggested construction for a circular casting machine. The arrangement is easily intelligible. The rim of the wheel is attached into a framework, in which moulds are mounted in such a manner that with every movement of the wheel they remain unchanged in a horizontal position. This is effected by suspending them upon trunnions, which are inserted somewhat above the center of gravity. It is the carriers of the mould which are mounted in this fashion, and the moulds themselves are firmly clamped to them. In case of an accident the mould only needs to be replaced. The strong trunnions are mounted direct in the frame, and sufficient play is allowed in the bearings so that the constant horizontal position of the mould is secured. By means of a spout and an adjustable casting trough, which may also be provided with a slag arrestor, the moulds are filled as they pass by, first those one side of the wheel, then those on the other. When the pigs in the moulds of the half of the wheel first filled are sufficiently cooled, the ejecting apparatus—of no matter what type—is brought into action, and the tipping of the moulds is effected. By means of suitable teeth on this device and a corresponding tappet on the levers of the mould carriages, a jigging motion is imparted to the former, which facilitates the ejection of the pigs onto a chute down which they slide to any transporting machinery that may be in use, and in which, during their passage, they are cooled with water. Inside the rim of the wheel there is a safety arrangement in the form of a semicircular trough which catches any falling fragments and carries them away in receptacles filled with sand. At a suitable position the spraying trough is located. In this rotating cylindrical wire brushes impart a coating of the material to the passing moulds. The speed of such a casting wheel would be about 4 inches per second if 12 moulds a minute are to be filled. The machine could be driven by a rope passing over a portion of the periphery. If with moulds capable of holding 150-pound pigs the diameter of the circular area necessary for their play be assumed to be 16 inches, then, with a diameter of the wheel frame of 66 feet, in round numbers, 150 moulds could be mounted upon each half of the wheel, making together 300. If two such wheels were introduced, the necessary number of moulds, namely 600, would be attained in a relatively small space. The iron could be tapped from a stationary receiver or mixer or poured from a ladle from which it could be delivered to the moulds by a movable spout in a very simple manner, or a special ladle might be used for each of the wheels, which would materially accelerate the filling of the moulds.

The whole of the operations could be performed on the floor level of the works, in the immediate vicinity of the blast furnace, and the space occupied by such a plant would not exceed that of an ordinary casting bed, so that the other half of the shed could be utilized as a reserve casting floor. Another advantage would be that the machine could load into the cars direct, as the pigs leave the shoot in a sufficiently cool state.

A POCKET TELEMETER.

WE illustrate herewith a very small form of telemeter devised by Col. Quinemant and manufactured



THE QUINEMANT TELEMETER.

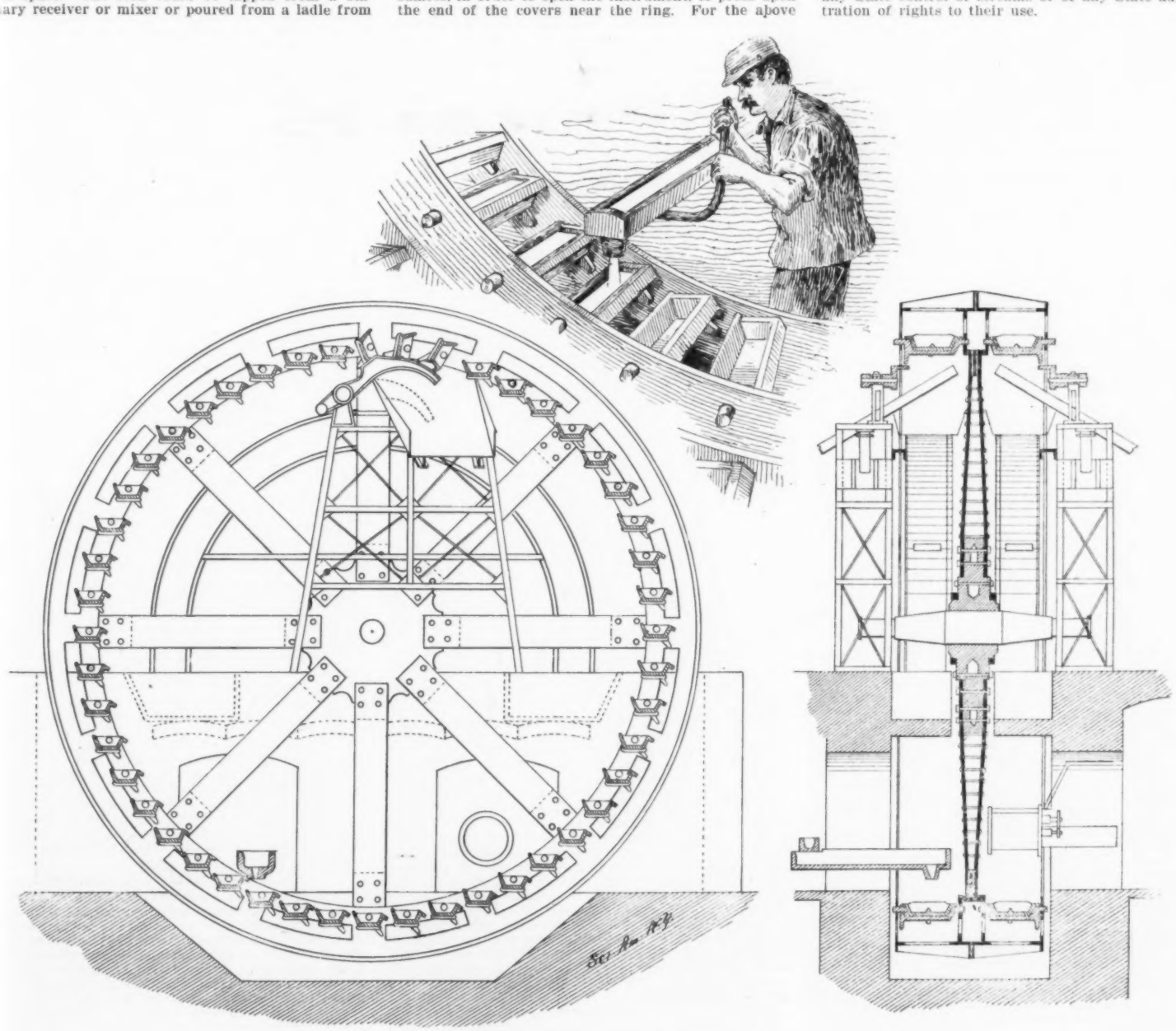
by M. Pouech. The apparatus really merits being described as minute, since it weighs but 450 grains and can be carried like a trinket by means of a ring fixed to its back when folded. It is 1.2 inch in length by 0.8 of an inch in width, and looks something like a book. Aside from the nickelplated copper case, it consists of two small mirrors and one large one, the first two arranged in one of the faces of the apparatus, and the other in the second face. A spring is arranged internally in order to keep the instrument open at a constant angle. Owing to the prolongations of the sides of the case, and to the play of the spring, it suffices, in order to open the instrument, to press upon the end of the covers near the ring. For the above particulars and the engraving, we are indebted to La Nature.

IRRIGATION IN CALIFORNIA.

THE United States Department of Agriculture will soon issue a comprehensive report (Bulletin No. 100, Office of Experiment Stations) on irrigation in California, which embodies the first attempt at co-operation by the Federal government with any individual State in the solution of intricate legal and economic problems underlying irrigated agriculture.

The investigations chronicled by the report, and upon which the conclusions and recommendations of the engineers in charge are based, were made in co-operation with the California Water and Forest Association during the summer of 1900, under the direction of Elwood Mead, expert in charge of the irrigation investigations of the Department of Agriculture, assisted by eight specialists in irrigation engineering and irrigation economics. In addition to a general review of the agricultural situation in California by the expert in charge, the report covers the local conditions of irrigation and water rights on nine typical streams, and brings to light astonishing facts about California irrigation, the nature and extent of which have never been appreciated by the people of that State. It shows that in many of the principal portions of the State agricultural development is greatly hindered because through the inadequacy of California laws, the waters which could and should make of them highly developed and valuable agricultural districts are flowing unused to the sea.

The report holds the chief obstacles to agricultural development in California to be an unremitting production of cereal crops in the great interior valley and a lack of more diversified farming; opposition to irrigation in districts which the census shows to be measurably decreasing in wealth and population; a too great zeal on the part of advocates of the Wright district law, followed by unwise investments which have led to loss and disappointment and a consequent opposition to irrigation laws of whatever nature; overappropriation of streams, resulting in confusing uncertainty as to the number and extent of valid appropriations; the conflicting nature of the water laws, and the existence, side by side, of the two opposing doctrines of appropriation and riparian rights; absolute private ownership of water in face of the fact that all leading countries where irrigation is necessary recognize only the rights of use and attach them not to the owner of land or to canal companies, but to the land itself, from which they are inseparable; and finally, and most important of all, the absence of any State control of streams or of any State administration of rights to their use.



BELANI'S PIG-IRON CASTING MACHINE.

The conclusions of the special agents and experts who made the investigations are that the State should ascertain the volume of available irrigation water, define all rights to its use, whether already acquired or to be acquired hereafter, and provide an efficient system of water administration. The definite recommendations for attaining these ends are far-reaching, embodying, among other measures, the creation of a State board of control of waters, similar to that in existence in Wyoming for the past ten years, the making of unappropriated waters State property, the limitation of all appropriations to actual beneficial use, and the attachment of all rights to water to the land irrigated. If carried out, they believe, these recommendations would put an end to the conflicts and controversies which now harass irrigators in California, and would place its irrigation law and development on a sound and permanent basis.

The special agents who carried on the investigations under the direction of Expert Mead and the streams to which they were assigned were as follows: W. E. Smythe, Susan River; Marsden Manson, Yuba River; J. M. Wilson, agent and expert in irrigation investigations, Cache Creek; Prof. Frank Soulé of the University of California, San Joaquin River; Prof. Charles D. Marx, of Stanford University, Salinas River; C. E. Grunsky, city engineer of San Francisco, Kings River; Edward M. Boggs, Los Angeles River; James D. Schuyler, Sweetwater River.

The general agricultural review of California, by Elwood Mead, the expert in charge, which opens the report, is also a summary of the work of the others. One of the most striking portions of this review deals with the value of irrigation water and the effect of irrigation on California land values. Land in southern California, which without water for irrigation was not worth $5 an acre, is shown to have sold, when irrigated and planted to orange trees, for $1,700 an acre, and instances are given where a water right of 50 miners' inches recently sold for $50,000, and where $3.50 an inch was paid last year for a twenty-four hours' flow.

Speaking of the great interior valley of California, Mr. Mead declares that the water supply available there for irrigation without injury to navigation ought to make of it the Egypt of the Western Hemisphere. "Within a radius of 5 miles," he says, "I saw every product of the temperate and semi-tropical zones which I could call to mind;" and continuing, he observes that there are more acres of irrigable land in the San Joaquin Valley than are now watered in Egypt from the Nile, where agriculture alone supports over 5,000,000 people. The irrigated lands along the Nile, he says, support 543 persons to the square mile, while on a 35-mile drive in the Sacramento Valley, over what is potentially one of the most fertile and productive agricultural districts on this continent, he saw only two schoolhouses, attending which were only 15 children. Just before taking this ride he had been for a distance of fifteen miles through an irrigated district in Utah, where there was not a farm of over 30 acres. The average population of the Utah district is over 300 to the square mile, that of the California district 10. "Every natural advantage is with California," he continues, "but the Utah district is irrigated, the other is not."

The laxity of the California irrigation laws could not be shown more forcibly than by the working of the law of appropriation, by which water may be diverted from its natural channel and used for irrigation on lands away from the streams. This is fully covered in the report. The law places absolutely no limit upon the amount of water that any individual may claim, and as a result more water is claimed from the nine streams studied than could be found in all the streams of the entire arid West. In Honey Lake Basin, where the ordinary spring flow of all the streams is only about 10,000 inches, the enormous amount of 28,000,000 inches is claimed, which, on the present duty of water in this region, is enough to irrigate over 200,000,000 acres of land. On Cache Creek, where the summer flow is under 10,000 inches, in addition to one claim of over four billion cubic feet and others aggregating 2,000,000 unintelligible units, over 7,000,000 inches are claimed. The filings on San Joaquin River amount to over eight times its greatest flood flow and those on the Sweetwater River call for five thousand times the existing supply. Yet, with all this multiplicity of claims, the law provides no way for their adjudication other than appeals to the ordinary courts of law, which the history of California irrigation as set forth in these reports shows, ends only too often in even greater complication and uncertainty than existed before the courts were appealed to. "The whole system is wrong," declares the report. "It is wrong in principle as well as faulty in procedure. It assumes that the establishment of titles to the snows on the mountains and the rains falling on the public lands and the waters collected in lakes and rivers, on the use of which the development of the State must in a great measure depend, is a private matter. It ignores public interests in a resource upon which the enduring prosperity of communities must rest. It is like A suing B for control of property which belongs to C."

No law or institution has given so much trouble to California irrigators as the English common-law doctrine of riparian rights, which was adopted by the first legislature of the State. In spite of having been supposedly abrogated by a later legislature, it has complicated almost every attempt to settle water titles in the State, because it is diametrically opposed to the California law of appropriation and wholly irreconcilable with the use of water in irrigation.

In closing the review of the situation, the expert in charge declares that "the reform of the irrigation laws of California involves the future of a great commonwealth. The possibilities which wait on success and the evils which will surely attend failure ought to enlist the efforts and intellects of the ablest and best men in the State. It is an opportunity for the exercise of constructive statesmanship which rarely appears in the life of any Commonwealth. The task is not to piece together the discordant fragments of laws and decisions which now control, but to create an irrigation code worthy of an enlightened and self-governing people. Success will mark the beginning of an economic revolution whose influence will be felt throughout the West. If the creation of institutions worthy of the time and place can come as a part of the world-wide movement of trade and population toward the Pacific Coast, and of material development of arid America by public and private aid, which is now being so strenuously urged, the opening years of the twentieth century will witness a new era of home-making in the West."

The report will contain between 400 and 500 pages, with thirty full-page plates of maps and half-tone illustrations, and also a large number of text figures.

ASIA, THE CRADLE OF HUMANITY.*

By W. J. McGee, Vice-President National Geographic Society.

Never have I been so overwhelmed with the magnitude of a task as in beginning this attempt to epitomize Asia in an hour.

Asia is the continent of continents; a giant land to which Africa is but an appendage and all Europe only an excrescence. Larger as to mainland than both Americas combined, Asia with her insular extension southeastward might swallow the great landmass of Africa with Europe in addition. Of the 50,000,000 square miles of land on the face of the earth, Asia holds fully 15,000,000, or three-tenths of all—indeed, stretching as she does from the equator to the very shadow of the pole and within a few degrees of halfway around the globe, she is as a world in herself, and can be likened to the rest of the planet only by means of superlatives. Her climate ranges from the utmost type of torridity to extremest cold, from heaviest equatorial torrents to bleakest aridity, from recurrent tropical typhoon to poleward calm. Her features are stupendous as her expanse is vast. The Himalaya Mountains and the Pamir Plateau—the Asian highlander's "Roof of the World"—make pygmies of all other elevations on earth. The world's most extensive plain forms central and northern Asia, and comprises the greatest tundra and vastest forest on the planet; one of the two largest deserts of the world (Gobi, with its extension in Takla-Makan) lies at the eastern base of this unparalleled upland, though out of the world's ten rivers exceeding 2,500 miles in length six are in Asia as against two in Africa and one in either America—and even this reckoning misses three of the mightiest among the world's waterways (Ganges, Brahmaputra, and Indus), rivers raised to foremost rank by unequaled loftiness of basin and swiftness of flow. Gaged by any measure, Asia is Titanic, the land of all lands in length and breadth, the queen of continents.

Great as is physical Asia, human Asia is far greater; for as the home of mankind and the cradle of culture she outcounts all the rest of earth. Out of the world's population of 1,500,000,000, nearly 900,000,000, or six-tenths of the whole, abide in Asia; out of the four or five or more races of men, all but one (the Amerind) are indigenes of Asia or its immediate insular and peninsular extensions; and if Egypt be placed with Arabia (where she belongs in every cultural aspect), then out of the fifty or eighty centuries of recorded history running from the hazy dawn of antiquity to the clear light of modernity, the earlier half must be credited wholly to Asia. Music and drama were old in Asia before Athens and Rome were planted, and oriental schools of painting and sculpture prepared the way for a nobler culmination in Greece and Italy. In industries, the long, long way from bestial tooth and claw to the stone knife and thence to the metal tool was first trodden by Asian folk and their Egyptian brethren; nearly all of the world's domesticated animals came from Asia, where horses and kine, sheep and swine, and the dog and fowl were tamed in the eastern morning of humanity (undoubtedly through uncounted generations of totemism and beast-worship after the manner of all lowly men) and the cat and the camel were caught in some part of that industrial tide which ebbed and flowed over the Red Sea basin for millenniums, while the hardy reindeer of the arctic and the ponderous elephant of the tropics were enslaved so late as yet to retain the characters of their wilder kindred; so, too, the world's richest crop-plants, like wheat and rice, oats and barley, were created in Asia by ages of experiment to feed millions, and to render all other lands eternal debtors to the queenly continent. The fundamental laws of the world, from mother-right to the Decalogue and from blood-venge to the Golden Rule, were framed in Asian centers and tested by the experience of millions before their germs were exported by Cecrops and Romulus and sown by Solon as seeds of future justice; and it is to Asia that the student turns for the longest dynasties, the largest nations, the grandest empires in history. Most of the well-springs of language flowing westward to unite in the great Aryan reservoir of world-speech arose in Asia; several Asian centers gave letters to the eastern world long before Cadmus came to Greece; and despite the teeming output of the occidental press of a century, a large share of the literature of the world is still Asian, and leading poets and prosaists of western lands are flocking back to the oriental storehouse for motives just as their contemporaries are building new towns out of the ruins (and for the spoils) of ancient cities. Of the nine world religions that have spread to millions of men—Shintoism, Brahmanism, Buddhism, Taoism, Confucianism, Judaism, Zoroastrism, Mohammedism, with the sublimation of their finest essences in Christianity—all were nurtured in Asia, and all but one attained highest development beyond the Bosphorus; indeed, of the modern sciences, three—mathematics, astronomy, chemistry—originated in the almacabala and astrology and alchemy of ancient Asia; while the metaphysical philosophies of even mid-European shrines are dull and feeble beside the ethereal emanations of the oriental mind, emanations so subtle yet strong as to react in bodily abnegation (in the self-immolation of the suttee, in the ecstatic self-torture of the dervish dance, and in the hypnotic self-paralysis of priestly fakirs) far transcending the saner powers of the western world.

Such is human Asia. Seen in any aspect, she is extended, picturesque, majestic, full of meaning; viewed in her various phases at once, she is bewildering in wealth of detail, if not an utter chaos of redundant facts. It were easier to deal with the human affairs of all of the rest of the world together than with those of Asia alone.

Happily the scientific student is not unaccustomed to dealing with chaotic assemblages—indeed, it is his business to classify facts by their relations, to reduce these to principles, and thus to bring order out of chaos. Now, in seeking to classify so vast an array of facts as that presented by human Asia, it were well to profit by the widest possible range of experience, by the wisdom of the ages as well as by the methods of modern science; and this is made fairly easy and safe by the nearly uniform ways in which the minds (and the tongues) of men respond to the stimulus of the unknown—for every language has its spontaneous interrogatives arising in natural order, whereby child and sage alike seek ever to enlarge their store of knowledge.

What (or who)? Where? How? Whence (and whither)? Why? These are the normal interrogatives of our vigorous language; they may be translated into other tongues so widely as to prove that they express spontaneous impulses of inquiring minds—indeed, they are thought-mates to demonstratives of voice or gesture shared by all higher animals; and their order is fairly uniform from prattling childhood to old age, and from savagery to enlightenment. Science finds guidance and strength in the unreckoned experience embodied in these nature-questions, yet reciprocates in full measure by defining the questions more clearly and fixing their order on a rational basis; and it is through this wedlock between common sense and practical science that the chaos of Asian facts may perhaps become understandable.

THE RACES OF ASIA.

What are the peoples of Asia? Time was when this inquiry would have been met by a list of the races occupying the great continent, defined by the standards of the day; and the enumeration might have ranged from two to a score or more, according to the definitions of the particular doctor thus opening the door to disagreement. Of late less attention is given to racial distinctions. The European in Asia (whether as adventuring cyclist or pomp-girt viceroy) is far less concerned with the racial affinities of the villagers than with their laws of hospitality or exclusion, their customs of eating and lodging; Dr. Talcott Williams touches race questions but lightly on his way to the far weightier questions of intertribal traffic and international commerce; Mr. Barrett passes easily from the practically immaterial race-bonds of the Far East to the vital relations arising in industries, and the potent influences founded on faith; Prof. Morse Stephens properly points to the racial bases of rank and caste in Indian society, but justly insists on the dominant importance of the economic factor by which the social lines have been maintained for centuries or millenniums; and Prof. Grosvenor summarizes Siberian history as a series of industrial and political stages each deeper and broader than the last, and all rising successively higher and higher above the bonds and barriers of racial affinity. These instances are merely straws indicating the drift of thought; they might be multiplied indefinitely; and all point toward the growing mass of current opinion that there are other factors of humanity of an importance transcending ethnic features and affinities. Yet the continent of continents cannot be comprehended in its fullness without some note of the indigenous races; and with a single exception the races of Asia are practically those of the world.

Passing over the multitude of minor details of fact and opinion, the peoples of the world may be assigned to five groups or divisions, conveniently termed races. These may be recapitulated as (1) the Caucasian or white race, indigenous in western Asia, transplanted to all parts of Europe, and now replanted in every land; (2) the Malayan or brown race, pertaining chiefly to southern Asia; (3) the Mongolian or yellow race, of eastern and northern Asia; (4) the African or black race, pertaining chiefly to central and southern Africa, but represented by the Negrito of southeastern Asia, the Blackfellow of Australia, etc.; and (5) the Amerind or red race, indigenous to the western hemisphere, but represented in northeastern Asia by immigrant Eskimo from across Bering Strait. It is not to be supposed that these groups are so trenchantly defined as to permit the confident assignment of every people to one or another of them; neither is it to be supposed that they indicate in any adequate way the origin and distribution of mankind over the earth; primarily they stand merely for a series of types or ideals about which peoples may be arranged conveniently, with more or less uncertainty concerning those of intermediate characters. At the same time the classification has the merit of expressing, albeit vaguely, an obscure and unmeasured attribute of humanity, which may be designated race-sense and defined as that instinctive sentiment holding unlike peoples apart and drawing like peoples into ever closer unity of character and purpose. Apparently the time has gone by for far-reaching classifications of mankind by so-called race-characters; the fact that the doctors disagree so widely is in itself an indication that there is something radically wrong with the system; yet the race-sense of primitive folk, with its feebler vestiges among even the most altruistic and philanthropic of mankind, is a factor with which the student must reckon, a trustworthy pointer toward some natural law.

CULTURE-STAGES OF ASIA.

In view of the overwhelming and ever-growing opinion that there are weightier factors of humanity than racial affinities, it behooves the student of human Asia to find some better way of classifying and describing the vast and variegated population of the great continent. Fortunately, such a way is at hand; it was developed through researches among the aborigines of America, mainly by Powell, and forms the basis of what has been called the New Ethnology—a science differing from its prototype in that it deals with men as human beings rather than animals, defining them by what they *do* rather than by what

* The closing lecture of the Afternoon Course of 1901 on "The Growth of Asia."—From The National Geographic Magazine.

they merely *are*. The classification is based on culture, using this term in a sense so broad as to include all that mankind know, all that mankind do.

Now when the multifarious facts of knowing and doing are first assembled and then assorted by similarity, certain kinds of knowledge and actions (or of activities, if a single term be used to denote both knowing and doing) are recognized, namely (1) knowledge and actions pertaining to the arts, or esthetic activities; (2) knowledge and actions pertaining to industries; (3) knowledge and conduct connected with convention or law, and collectively constituting the social activities; (4) knowledge and practices involved in speech and writing; and (5) opinions and observances connected with faith and philosophy, or sophic activities. So, in brief, all that men know and do (and hence what in active sense they *are* in the visible economy of the cosmos) may be summed as pertaining respectively to arts, industries, laws, languages, and systems of faith or opinion. Furthermore, when the numberless facts pertaining to each great activity are assorted by similarity, they are found to reveal phases which are fairly consistent among the several activities of each people, yet more or less diverse among different peoples; and by these phases of culture the peoples of any continent, or of all, may be classified more usefully than by racial affinities—for the culture-phase is the real index to what the people think and do, to their attitude toward one another and toward other peoples. These culture-phases have the additional and immeasurably great advantage of indicating stages of development—but of that more anon.

Now the coincidence between culture and the activities (or the harmony between what men know and what men do) is so close that the culture-phases may be outlined in terms of arts, industries, and the other activities, either separately or jointly; and it is convenient and customary to define the phases in terms of law or social organization, with due reference to the attendant faiths—for it is to be remembered that only a fraction of mankind have dissevered civil from ecclesiastical law, statute from commandment, justice from faith. Defined in this way, culture begins in that obscure phase shared by men and such animals as most nearly approach the plane of human thought and conduct (like the Bandar-log of Kipling); and this indefinite condition is followed by the well-established phases of (1) savagery, in which the sole law is the social one of maternal blood-kinship accompanied by a profound animism—i. e., faith in a vague pantheon of beast-gods; (2) barbarism, in which the laws are chiefly social, in which society is based on real or assumed consanguinity traced through the paternal line, and in which sun, fire, and other impressive nature-objects are personified, either as beasts or as men, and added to the pantheon; (3) civilization, in which the laws relate primarily to territorial and other proprietary rights, while the beliefs are more or less completely spiritualized, the civil and ecclesiastical functions more or less completely divorced; and (4) enlightenment, in which the law is based on the right of the individual to life, liberty, and the pursuit of happiness, and in which faith works as a moral force. The first two of these phases represent tribal law, the last two national law; and it is especially noteworthy that throughout all tribal culture the law is dominated by faith, while in national culture faith is blent with, or controlled by, the principles of justice and right established by experience.

Classified by culture-phases, human Asia loses nothing of her supremacy among the continents save at a single point; three of the great classes are represented among her peoples, two of them (barbarism and civilization) more numerously if not more typically than elsewhere on earth; she lacks only indigenous enlightenment—that broadest phase of culture which all the world awaited until it budded in Switzerland and blossomed in America.

PEOPLES OF ASIA.

In the light of this classification the first large question as to the peoples of Asia is easily answered: They comprise an assemblage, with more or less intermixture, of all the world's races; they comprise a few tribes of lowly savages still clad in leaves, still fearing and worshiping beastly associates, still clinging to the beastly diet of raw fruit and flesh, still dreading contact with alien men and broader culture; they comprise also the world's best and largest examples of barbaric life, from its poorest squalor to its richest pomp and circumstance; and they comprise subjects of monarchical nations of nearly every known type from pettiest principality to most resplendent empire.

In the light of the same classification it would be a simple task to answer together the second and third great questions as to human Asia—i. e., Where are the peoples? How do these peoples live, move, and have being? But such is the vastitude of the queenly continent, the magnitude of her population, the multitude of her tribal and national divisions, that the full answer would inevitably reduce itself either to a mass of statistics, or to a catalogue of facts summarized in every encyclopedia, even in scores of school geographies—the facts are literally, in the phrase of the auctioneer's bill, "too numerous to mention." Yet facts of object, place, and agency too many for statement but form a chaos which all scientists of recent years concur in reducing—or at least in seeking to reduce—to the order suggested by the fourth nature-question, Whence? And this inquiry is answered by a statement of the facts in terms of genesis, growth, evolution, or (to use the broadest term of all) development. The genesis of the primeval Asian is indeed lost in the haze of prehistoric antiquity, or even worse enshrouded in the mists of myth-burdened tradition; yet the sciences of geology and archeology and ethnology, on the one hand, and critical history interpreted in their light on the other hand, combine to illumine in some degree the obscure problems of early man. So, too, the chains of developmental succession among the races and peoples, tribes and nations, of the great continent are regrettably incomplete; many links are lacking even from the longest, while some are too short to give good ground for confidence concerning their invisible portions; yet all are sufficiently consistent in trend, and so far accordant in direction with those found in other lands and among other peoples, as to render them worthy of tracing.

A BIRTHPLACE OF MANKIND.

Most, or all, of the leading naturalists and anthropologists of the day agree fairly as to a probable birthplace of *Homo sapiens*. Ernst Haeckel, the foremost German naturalist of his generation, assumed that the human species originated in a now submerged region between India and northern Africa, known as Lemuria, the land of the lemur; Brinton, recognizing the vestiges of mountain life in the morning of humanity, looked to the upland zone stretching from the Alps to the Himalayas, and especially to the western part of this belt, as the home of man primeval; Keane finds suggestions of four birthplaces for so many widely distinct race-stocks, but locates all in the same quarter of the globe; while other students, impressed by the evidence of lowest savagery that primeval man must have been both arborean and orarian—both forest-dweller and shore-dweller—and impressed also by the archeologic evidences of antiquity in southern Asia, have regarded the shores of the Indian Ocean with its affluent bays as the region of earliest human development. Within a few years these inferences have been strikingly corroborated by the discovery of the long-mooted "missing link," *Pithecanthropus erectus*—upright monkey-man—in late Pliocene deposits of Java by Eugène Du Bois. This discovery was of prime importance to the scientific world, and especially to the student of Asia, on various accounts; in the first place, the bones are more nearly intermediate between those of Homo and those of the higher subhuman anthropoids than any skeleton known before; in the second place, the geographic position of the fossil serves at once to verify previous inferences and to locate more clearly than any (or indeed all) other evidence the home of a human prototype; while, in the third place, the deposits in which the remains were found afford the most trustworthy record of the geologic age of a Homo-like creature thus far obtained.*

So the *Pithecanthropus erectus* of Du Bois gives the starting point for the tracing of human development on the continent of continents; the testimony of the fossil is supported by other scientific evidence already written in entire volumes; and when interpreted in the light of known human development, it is in significant harmony with the world's oldest lore and earliest literature—for it marks the quarter of the earth glorified as the place of creation in the traditions of the Far East, in the sacred books of the East, in Hellenic mythology, in the more mystical portions of the Koran, as well as in our own Classic of the Ages, and in the belief of most of humanity. The prevailing faith of mankind is not, indeed, of a kind with the testimony of rocks and fossils; yet the dusty evidence is enlivened by its harmony with the essence of knowledge summed in the coincident traditions of many peoples.

COURSE OF HUMAN PROGRESS.

In tracing the obscure trails of early human development, it were well to avoid a notion instinctive to all mankind, fostered by hero-worship and honorable regard for worthy grandsires, kept alive by the unassailable doctrines of biology, and adopted by every anthropologist at the outset of his career (and dropped only by part of them as their studies progress)—i. e., the notion that the human genus necessarily sprang from a single parentage, necessarily arose in a single place. The fact that the genealogic tree of the biologist is the antithesis, or reverse, of that of the genealogist, receives too little attention: the one begins with a known or assumed primordial form, and divaricates and diverges forward in time to a diversified progeny; while the other begins with a certain descendant, and bifurcates and expands backward in time to a diversified ancestry. Now the dominant fact of anthropology—the fact attested by every experience and denied by no observation—is well illustrated by the tree of human genealogy; it is the constant *convergence* of developmental lines, whereby families are united in clans, clans blent into tribes, tribes joined in confederacies, racial lines obliterated, cities assimilated in states, and states combined in nations. The great fact brought out by the science of man is that human stocks, whether of blood or belief, language, or industries, are not originating, have not originated since history began, and are steadily blending, running together into that great magma of humanity already encircling the globe and surely pushing into the most distant corners of the remotest lands. How many were the original races no man may say; Keane estimates four primary race-stocks, but this number might be multiplied, probably many times, without violence to any known fact or direct generalization in the entire domain of the science of man. The Gordian entanglement of innate notion, biologic doctrine, and anthropologic observation may not readily be undone; it suffices to sound a warning against the besetting hypothesis of monogenesis, and note the greater probability that, just as the inhabitants of India are not a people but many peoples, so the ancestry of human Asia is to be traced not so much to *man* primeval as to many *men* primeval scattered in separate colonies along her fertile and fruitful southern shores during the geologically near, but historically remote, period of the later Pliocene.

Beginning with the *Pithecanthropus* colony and a dozen or a score others, and assuming that the habits of the prototype stood midway between those of the higher anthropoids and surviving savages, various glimpses of the inevitable lines of development may be caught. At first the colonies were clans or enlarged families, something like those of the gorilla, more like those of the Australian blackfellow and the American red man, each antagonistic to all others: in time some of these grew into the custom of inter-clan mating, thereby learning for the first time in the human world the great lesson of experience, that in union there is strength; in this way some clans grew into tribes, while others were either absorbed or extinguished under the hard law of natural selection—and the vestiges and proof of this stage survive today among the leaf-wearing and rat-eating savages of southeastern Asia, savages whose gods are beasts and whose worship is debasing fear. In this stage the law of organization was maternal descent—for at the outset and long after, the mystery of paternity remained unsolved. With the growth of tribes along the fecund lowlands, some were forced into the adjacent uplands, and eventually into the higher mountains; the relief from tribal pressure brought partial surcease of strife, yet demanded harder peaceful labor, sharper shrewdness in the chase, greater activity of body and mind; so that those who would purchase peace bought at the cost of vigorous exercise, yet were in due time rewarded by the superior faculty born of stressful organic function. Incidentally those who pushed highest on the Titanic stairway leading to the roof of the world breathed the more deeply and of a purer air; the hepatic activity required to throw off the miasmatic poisons of the coast diminished, and the respiratory activity required by the longer journeying and steeper climbing increased in larger measure—and thereby the excess of pigment in skin and inner tissues was eliminated, and the face of the human forbear bleached to brown, to yellow, and at last to the tinted whiteness of standards which grew as the color changed. This was but one of the ways of human beautification, whereby prognathic jaws were retracted, arms shortened, legs straightened, and the hirsute covering cast off and concentrated to the feminine crown and masculine halo—but this most entrancing of all the lines of human progress, measuring as it does the rise of young affection and the growth of human feeling, must be passed over.* Meantime strength grew with exercise and self-confidence with strength, until the hill tribesmen and the denizens of deserts made conquest of their animal contemporaries, slaying the fierce and taming the gentle, and so far made conquest of trees and rocks as to utilize them for tools and utensils; and as self-confidence grew, fear and worship were withdrawn from visible beasts, from tangible trees and rocks and rivers, and were concentrated on the remoter mysteries of sun and storm—though these were long personified as superpotent animals. Meantime, too, the problem of paternity was solved, and the law was so reconstructed as to cluster about paternal relationship. This stage in the development of the Asian people is represented to-day by some of the hill tribes of India, some of the remoter folk of Thibet, some of the groups about Lake Baikal; it is represented also by the world's best-known records of patriarchy in olden times.

The meaningful feature of the growth from savage clan to patriarchal tribe thus outlined is its spontaneity, its necessity; for, with the given conditions of organic structure and budding intelligence, the way from savagery to barbarism is certain and sure as the growth of the plant from its seed, as the development of the insect from egg to larva, as the flow of a river formed by highland tributaries on its way to the sea. Herein lies the lesson of the special usefulness of the great culture-phases in the classification of mankind; they may be likened to the insect stages of ovum, larva, pupa, imago; they may succeed more swiftly or linger longer in coming, but under natural conditions they *must* follow their established order of growth, unless interrupted by the extinction of the stock. Nor is it to be supposed that the stages are hypothetic or uncertain; for their definition rests on the sum of observed facts not only of Asian peoples, but of those of all the world.

THE RISE OF NATIONS.

Now the hill tribes of Asia at first developed faster than those of the shorelands, and sent branches or isolated colonies in all directions; one of the earliest, and in all respects the most noteworthy, of the human streams trickled westward through the passes of the Caucasus and over the sands of Suez, to grow gradually into the world's greatest peoples; another branch apparently crept around the western flanks of the Pamir, and then filtered eastward to form the tribes of the Middle Kingdom, to displace the earlier comers by more easterly routes, and to grow at last into the world's most populous empire; still other rivulets flowed northward even unto the shores of the Arctic; while some of the strongest streams of blood and culture ebbed again toward the Indian lowlands, sweeping the most sluggish indigenes westward to the Dark Continent (where they doubtless foregathered with local groups) and eastward into Malacca and the great archipelago stretching thence to Australia. Yet not all of the indigenes were displaced; enough still remain to form that stratified series of peoples and cultures described by Prof. Morse Stephens and defined by the world's most striking examples of race-sense—for, in spite of the economic factors, the castes of India find their roots in racial antipathies.

The story of the growth of inter-tribal commerce, of the Alexandrian invasion, and of the pushing of Asian influence into Europe has already been told by one of us;† the story of the welding of Mongolian tribes into a nation and empire, and of the westerly crusade aimed for Christianity but content to stop at Buddhism, has been told by another;‡ the story of slow confederation among the tribes of India, and of more rapid national assimilation under the influence of alien empire, has also been told;§ while the story of the absorption of those northern tribes occupying the world's greatest woodland and tundra by one of the foremost world-powers is still fresh in mind.‖ So these events and episodes of Asian development, important though they be, may be passed over.

HUMAN ANTIQUITY IN ASIA.

The developmental outline of human Asia would be incomplete without some intimation as to the relative antiquity of mankind on the great continent and else-

* The most accessible and satisfactory account of this fossil may be found in the Smithsonian Report for 1898, pp. 445-459, pls. 1-111, figs. 1-4.

* The subject may be pursued in "The Trend of Human Progress," American Anthropologist, n. s., vol. 1, 1899, pp. 415-418, and in "The Seri Indians," Seventeenth Report of the Bureau of American Ethnology, part 1, 1898, especially pp. 154-163, 279-287.

† Dr. Talcott Williams on Western Asia; "The Link Relations of Southwestern Asia."

‡ Hon. John Barrett on Eastern Asia; printed under the title "China: Her History and Development."

§ Prof. H. Morse Stephens on Southern Asia; soon to be printed.

‖ Prof. Edwin A. Grosvenor on Northern Asia; also soon to be printed.

where. Fortunately the geologic estimate is made definite for Asia, and for other lands as well, by the finding of the fossil prototype, *Pithecanthropus*, in late Pliocene deposits; and so far as definite knowledge goes this forms the geologic and archeologic datum-point for the world. The archeologic record is consistent with that of geology, in so far as the time-measures of the two sciences are commensurate; the partly traditional history of China runs more than fifty centuries into the past, yet begins with accounts of conquest over earlier peoples and with great eras* which must have begun far earlier still; the sacred books of India summarize several milleniums of history from the days when "the noble races had to struggle with the low-caste tribes, people of black complexion and flat nose, and even with the Anasikas, demons, and monkeys," up to modern centuries—and even at this beginning there were long eras, like the Kali-yug, implying traditional preservation of observations for millenniums already past; and throughout southwestern Asia and Egypt ruin is superposed on ruin, and the later ruins are so identified by records of fifty centuries and more of history as to indicate an occupation of certainly 80 to 100, and probably 150 to 200, centuries from the beginning to the present. The historical record of human Asia is long, very long; the archeologic record runs a long way farther into the past through a succession of relics and ruins beyond compare in Europe or Africa, immeasurably beyond the earliest human traces of the western world.

So, it is just to consider Asia the cradle of humanity; within her ample borders the earliest races sprang, over her shorelands and uplands the earlier culture-stages were developed, and from her plains and mountains all other lands were at least partly peopled. More than this: Asia witnessed within her own borders the natural growth of nations from crude confederacy at the beginning of barbarism to brilliant empire. Yea, and still more: Asia illumined the world with its brightest examples of ennobling faith, from the crude Shamanism and Shintoism that did good service in their time, through higher and higher stages to the Golden Rule of Confucius in the Far East, to the Light of Asia in the great midland, and at last to the Light of the World in far western Palestine.

THE WORLD'S DEBT TO ASIA.

On the whole, when the continent of continents is fairly viewed in her length and fulness of history as in her breadth and wealth of land, Asia must be held at once the cradle of humanity, the birthplace of nations, the nursery of the world's religions; and all right-thinking men must hope that the debt of the western world to the queenly continent will be paid in full measure, and in peace and good-will to the men of ancient lineage, whether their skins be brown or yellow.

A SIMPLE METHOD OF LIGHT WAVE MEASUREMENT.

By L. H. HORNER.

THE measurement of a distance so minute and a motion so elusive as a light wave may seem to be beyond the power of the amateur experimenter, but a fair result may be obtained by no more complicated means than a microscope eyepiece micrometer, a foot rule of fair accuracy divided to thirty-seconds (or, better, a metric scale divided to millimeters), a candle and some bits of fine wire.

The "undulatory theory of light," now two hundred and thirty years old, asumes a light wave to be a minute replica of a water wave, i. e., a transverse wave, a form of motion which lends itself so perfectly to the explanation and even prediction of light phenomena that it may be accepted provisionally as a working theory, a framework to build the comprehensive "electro-magnetic theory of light" step by step. The parts of a so-called "transverse" wave are given in Fig. 1, where L denotes wave length, L-2 half

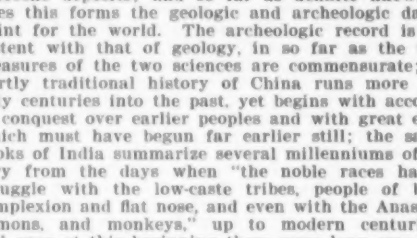


FIG. 1.

wave length, A amplitude of vibration, P phase of vibration, i. e., crest or hollow, x-x surface of equilibrium.

The arrow gives direction of motion of a mobile particle at right angles, i. e., transverse to the forward direction of travel of the wave.

Since the method of light wave measurement to be described is based upon the observation of the so-called "interference bands or fringes," several easily performed experiments in the "diffraction" of light may serve as preliminary practice and reveal interesting and beautiful phenomena as well.

Experiment 1.—When a gas jet turned very low to present a point of light, is viewed through a smear made by a slightly greasy thumb on a sheet of glass, a streak of light banded with a succession of rainbow tints is seen.

A common effect of diffraction is also observed in the four-rayed star of light radiating from a source of light viewed through a piece of window-screen or muslin. It will be noticed that in every case the rays of colored light are at right angles to the direction of the intercepting lines.

Using the same source of light as in Experiment 1, a similar effect is seen in looking through a clean knife-cut in a sheet of tinfoil dampened and pasted on glass; or, to secure even better results, two slits should be arranged as shown in Fig. 2.

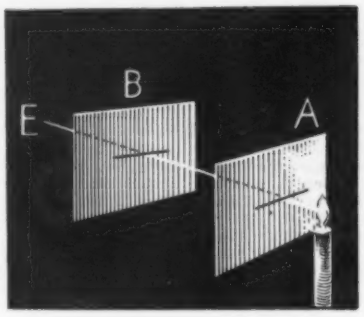


FIG. 2.

For the slit, B, the substitution of a smooth-edged pinhole shows concentric bands of color.

Experiment 3.—The beam of light emerging from the slit, A, is viewed through a small lens (as of a pocket magnifier), across the opposite face of which a hair is stretched by means of a bit of glue or wax at each end and held parallel to the slit.

In this experiment, due to Baden-Powell, two distinct series of parallel bands are seen—one series, rather coarse, gradually fading away from each side of the hair, and the other series exceedingly fine, of equal width and brightness throughout, within the narrow geometrical shadow of the hair (see Fig. 3).

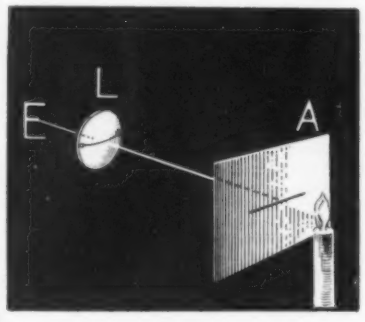


FIG. 3.

The colors in these "interference bands" are always presented in a certain order, the violet on the side nearest the streak of light and the red farthest away—the same succession of colors seen in the primary rainbow or inner bow, the one most generally seen after a shower, when the violet appears on the side of the arc nearest the sun.

If now the white light be rendered "homogeneous"

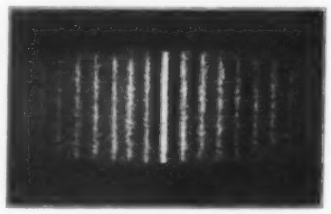


FIG. 4.

by sprinkling the flame with common salt, the bands lose their rainbow tints and take on the distinctive yellow color of sodium, presenting an appearance as in Fig. 4, and it is with the observation of similar yellow bands that we have to deal.

Arrange an apparatus in the manner of Fig. 5, in which G is the "grating" (i. e., the microscope eyepiece micrometer), E the observer, S the scale, F the source of light, R the wire "riders."

The grating, being the vital part of the apparatus, should be accurately and closely ruled; an eyepiece micrometer being as cheap and accurate a substitute for a "diffraction grating" as can be found.

The grating and scale should be set parallel, and with the flame all placed in the same level; the rulings of the gratings being vertical, and parallel to the graduations of the scale.

The flame should present a mere point of light, and be placed as near the scale as possible without scorching.

The distance of the grating from the flame may be one, two or even three meters (or yards), as is found consistent with the distinct vision of the parallel yellow bands seen in looking through the grating.

The eye of the observer being brought close to the lines of the grating, an assistant as directed places upon the scale small wire "riders," bent to a square U shape, to mark the superposition of the yellow bands upon the scale.

The formula used in the experiment is:

L equals d sin. θ, where L is the wave length, d the "constant" of the grating, i. e., the distance apart of the rulings; θ the angle included between lines drawn to G from the flame and to the center of the first band to the right or left.

These relations are shown in Fig. 6.

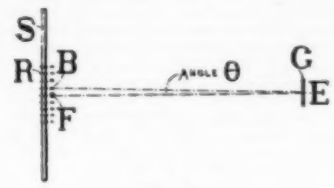


FIG. 6.

From the distance, $F B$, i. e., the distance apart of the bands, determined as the mean of several trials, and $F G$ assumed in the arrangement of the apparatus,

$$B G = \sqrt{(F B)^2 + (F G)^2}$$

$$\text{and sin } \theta = \frac{F B}{B G}$$

In an experiment by the writer,

$d = 0{\cdot}1$ mm.
$F G = 1.0$ m.
$F B = 6.0$ mm.

Hence $B G$ was found 1,000.179 mm. Whence sin. $\theta = 0.0059$. And $L = \frac{0.0059}{10}$ or 0.00059 mm. for the wave length corresponding to Fraunhofer line D_1 of yellow spectrum light.

The measurement of D_1 will be found the most satisfactory for the amateur, owing to the ease with which a homogeneous yellow light may be secured by the use of common salt.

As means of comparison the latest determination of D_1, that by Louis Bell, gives $L = 0.000589618$ mm. in air at 20 deg. C. and 760 mm. barometric pressure.

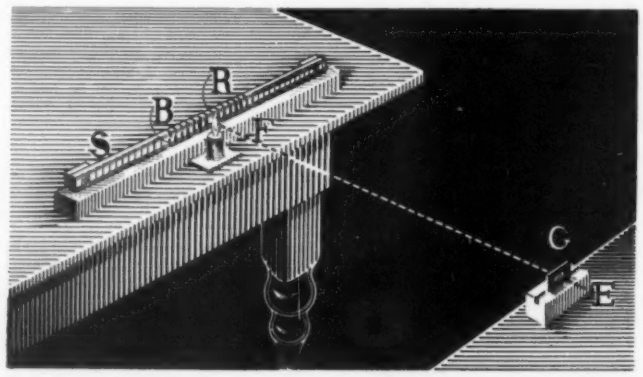


FIG. 5.

NEW ARC-LIGHT ELECTRODES.

Two patents have been recently granted to Hugo Bremer, of Neheim, Germany, for the material of arc-light electrodes and for a form of arc-lamp, says The New York Post. The electrode, it appears, is of the kind in which a metallic salt or salts is mixed with pure carbon, but with the addition of another substance which comprises the new feature. It is stated that disturbing influences have stood in the way of application of metallic salts, first through the scorified secretions of the salts, and, secondly, through the circumstance that if the percentage of metallic salts is increased and the amount of carbon reduced accordingly, the heating effect produced by the combustion of the carbon is greatly reduced so that the metallic vapors are not completely brought to incandescence. The scorified secretions, on the other hand, will sooner or later form an incombustible coating which will eventually smother the arc. The principle on which the Bremer invention is based consists in the introduction in the electrode of boron or fluorine, whereby the otherwise solid scoria will be softened or liquefied, thus causing them to drip off periodically. In order that the fluxed scoria may drip off and not interfere with the light, the round form of carbon pencil is not used, the cross sections illustrated in the patent being of such a shape as to present sharp edges, such as a square or a section with four concave sides.

A specimen claim is for an electrode composed of pure coal and of from 10 to 17 per cent of metallic salts

* Chinese chronologers reckon their history by dynasties running back to the era of Yao, beginning B. C. 2357. Still more impressive are their natural time units; for not only were the Chinese astronomers familiar with the lunisolar period (or eclipse cycle) of 7,421 lunations or 600 years, known as the Chaldean naros, long before the cycle was recognized in the west, but they conjoined this with an arbitrary period of 60 days to form the Chinese Great Year of 57,105 lunations, or 4,617 years (Bibliographie Générale de l'Astronomie, par J. C. Houzeau et A. Lancaster, tome premier, première partie, 1887 [Introduction], p. 95; cf. "Comparative Chronology," American Anthropologist, vol. v, 1892, pp. 327-330).

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or metalloids, such as calcium, magnesium, glass, fluorspar, and the like, in combination with a high quantity of boron and fluorine, and a further quantity of 25 per cent of fluorine, bromine, or iodine—the electrode being provided with ribs or grooves to receive a sharply-edged section. For an electrode, the light of which shall give a yellowish tint, fluorine may be used mixed with the carbon in conjunction with more than twice its quantity of calcium or calcic salts; a more whitish tinge may be given to the light by adding some magnesium. It is stated that the easiest way to add the fluorine and boron is to bring it in connection with the other metal salts, such as cryolite or fluor calcium, or to mix the pure carbon with fluor carbonite.

CONTEMPORARY ELECTRICAL SCIENCE.*

RESISTANCE OF BISMUTH.—One of the many anomalous properties of bismuth is the change which the resistance of a filament undergoes when placed perpendicular to the lines of force in a strong magnetic field. Not only does its resistance very much increase, but, as discovered by Lenard, its resistance to alternating currents under these conditions is apparently different to its direct-current resistance. Lenard thought this difference only became manifest at frequencies of 10,000 per second and upward, whereas Sadovsky observed a difference even at a frequency of three or four per second. G. C. Simpson attempts to discriminate between the two by means of experiments based upon the following principle: As any small change in the resistance of a wire carrying a current may be considered as the result of an E. M. F. set up in the wire, whatever the changes in the bismuth may be due to, they can be regarded as arising from an E. M. F. set up in the bismuth itself. If on examination this E. M. F. (called in this Paper the "bismuth E. M. F.") should prove to be opposite in phase to and of the same wave-form as the—say simple harmonic—current causing it, it may safely be inferred that the change in the bismuth is really a change in the resistance pure and simple. But if the "bismuth E. M. F.," while still possessing the proper wave-form, should be displaced 90 deg. ahead or 90 deg. behind, it would be necessary to conclude that in the one case there exists something of the nature of capacity, in the other something of the nature of self-induction in the bismuth. The results of the experiments go to show that the latter alternative holds good for small frequencies, and that the rise of resistance is only apparent.—G. C. Simpson, Phil. Mag., September, 1901.

DISRUPTIVE DISCHARGE IN ELECTROLYTES.—Broca and Turchini found some time ago that a disruptive discharge may take place in an electrolyte in very much the same way as it does in a dielectric. This, as K. R. Johnson points out, is the conclusion which he had arrived at independently. His experiments were made with Wollaston electrodes, which enabled him to make the spark issue from one electrode independently of the other, the explosive distance being furnished by the gas disengaged round the platinum point, and the spark passing between that point and the liquid. To produce the discharges, the author employed an induction coil, a Tesla transformer, and finally a Blondlot resonator. In the last case the discharge was entirely suppressed. In employing an induction coil the author observed that the disengagement of hydrogen and oxygen is solely due to the current at break, the current at make not exercising any electrolytic action. This may, in fact, be easily demonstrated by making and breaking the circuit by hand. It is evident that the electrolytic effects arise from the oscillations which accompany the induced current, and not from an alternative action of the two induced currents.—K. R. Johnson, Comptes Rendus, August 5, 1901.

CAPACITY OF THE HUMAN BODY.—Bordier placed the electric capacity of the human body at 0.0025 microfarad and Dubois at 0.1650 microfarad. Both these figures are much in excess of the true capacity according to the recent researches of G. de Metz. The latter measured the capacities of several persons under all sorts of conditions, and found that the capacities were the same in the nude and when dressed in close-fitting conducting material. The obvious conclusion is that the capacity of the human body is the same as that of a metallic body of the same dimensions, and this conclusion is fully substantiated by the other measurements. The capacity remains the same for any charge between 100 and 1,000 volts, but differs from one person to another in accordance with the volume and shape of the figure. It changes rapidly when the person is surrounded by metallic surfaces, and also greatly depends upon the pose. Thus the value of 87.8 cm. was obtained in an upright position, 76.0 cm. when crouched, and 91.2 cm. when erect with one arm stretched forward. When placed on a rubber mat and surrounded by a zinc cylinder 138 cm. in diameter the capacity was 180.7 cm., and it rose to 217.9 cm. on reducing the diameter of the cylinder to 68 cm. The normal value of an erect pose in the center of a hall is 0.00011 microfarad for an individual of average stature.—G. de Metz, Comptes Rendus, August 5, 1901.

MAGNETIC PROPERTIES OF HUMAN BLOOD.—Faraday found, much to his surprise, that blood, although containing a large proportion of iron, was diamagnetic, and was led to state that "if a man could be suspended with sufficient delicacy, after the manner of Dufay, and placed in the magnetic field, he would point equatorially; for all the substances of which he is formed, including the blood, possess this property." Plücker showed further that the blood corpuscles are more strongly diamagnetic than the liquid in which they float. A. Gamgee has now proceeded a step further, and examined the magnetic properties of the crystalline blood-coloring matter itself, in the condition of utmost available purity. He comes to the conclusion that the blood-coloring matter, oxyhæmoglobin, as well as carbonic-oxide hæmoglobin and methæmoglobin, are decidedly diamagnetic bodies. The iron-containing derivatives hæmatin and acethæmin are, however, powerfully magnetic bodies. The differences in magnetic behavior between the blood-coloring matter and acethæmin and hæmatin point to the profound transformation which occurs in the hæmoglobin molecule when it is decomposed in the presence of oxygen. The preliminary study of the electrolysis of oxy-hæmoglobin and CO-hæmoglobin renders it probable that, in the blood-coloring matter, the iron-containing group, on which its physiological properties depend, is (or is contained in) an electronegative radical; according to analogy, the iron in such a compound would possess diamagnetic and not paramagnetic properties.—A. Gamgee, Communicated to Roy. Soc., June 20, 1901.

*Compiled by E. E. Fournier d'Albe in The Electrician

A 150-TON ELECTRIC CRANE.

AMONG the most interesting of the powerful hoisting apparatus constructed in recent years may be mentioned the 150-ton electric pivoting crane installed at the entrance of the new repair basins of the port of Bremerhaven, situated near the mouth of the Weser, 36 miles below Bremen. This crane, which is of unusual dimensions, and is designed for the fitting out of ships, constitutes a most interesting innovation. It comprises two very distinct parts:

1.—A stationary metallic scaffolding having the form of the trunk of a rectangular pyramid, terminating at the top, at 86 feet from the ground, in a crown of flat and figured iron.

2.—A movable framework, in the form of a T, capable of revolving around its vertical axis. The vertical part rests upon two roller paths, one situated at its lower part at the level of the masonry foundation, and the other upon the crown of the scaffolding. The principal frame pieces of the vertical part spread outwardly toward the summit and support a rolling bridge. Upon one of the arms, of which the girders are more powerful, moves the motive carriage. The other arm, upon which are established transverse braces, is provided at its extremity with a counterpoise for balancing the load.

150-TON ELECTRIC PIVOT CRANE.

Owing to such arrangements the resultant of the movable part (the crane properly so called, the load and the counterpoise) is vertical and constantly passes through the lower joint, thus assuring the stability of the system. The lower roller path has a mean diameter of 7.2 feet. The rotation is produced through 35 tempered steel conical rollers 7 inches in diameter and 10 in length, moving in a bath of oil between two horizontal plates, one of which is operatively connected with the crane, and the other is fixed upon the foundation masonry.

The total height of the apparatus is 118 feet. The maximum range is 72 feet, and the effective range, from the edge of the wharf to the extremity of the rolling bridge is 44.28 feet.

Finally, all parts of the apparatus are reached by stairways. The rotary motion is obtained by means of an electric motor of 26 horse power capable of making 550 revolutions a minute. This motor, through the intermedium of a double-threaded worm gearing and a set of toothed wheels, actuates the lower plate of the crane. The system is thus capable of making one complete revolution in about 2 minutes, which gives for the tackle, and consequently for the load, a velocity of nearly 32 feet a minute.

The frame of the carriage upon the rolling bridge carries three electric motors, two of which actuate the tackle and one produces the motion of the carriage. The latter is provided with four pairs of driving wheels mounted in special frames. The tackle that supports the load is formed of seven pulleys, arranged in two parallel and superposed rows, over which passes a steel wire cable 2.25 inches in diameter and having a resistance to traction equal to 150 tons.

The motive windlass of the carriage comprises two cylinders around which the cable makes but a few turns, since as the height of elevation of each loop of the cable is capable of attaining 98 feet, it would have required a total winding of 784 feet and the use of a much larger drum. In order to avoid such an inconvenience, the cable, upon leaving the windlass, passes over two guide pulleys mounted upon trolleys and connected with the carriage, the movement of which they follow. The cable afterward passes in the axis of the crane over pulleys that support a 1,100-pound counterpoise.

The two electric motors that actuate the windlass, and consequently the tackle, are of 17.5 horse power each. They are wound in series, make 450 revolutions a minute and act upon one shaft in common, provided with electro-magnetic brakes. Different systems of gearing permit of changing the velocity of hoisting according to the importance of the load, and that, too, without changing the tackles. Thus, for a weight of 150 tons, the speed of hoisting should be 27 inches per minute, while for loads of 75.37, or 18 tons, it would reach respectively 4, 5, 9, 8 and 20.6 feet per minute.

In addition to the electro-magnetic brakes arranged upon the driving shaft, and designed to operate in case of an accidental interruption of the current, or of a false maneuver, the apparatus comprises two mechanical brakes that act in case of a breakage of the gearings and serve also to retard the motion during the descent of a load.

The motion of the carriage is obtained by means of an electric motor of 26 horse power, making 550 revolutions a minute and acting through a single-threaded worm gearing upon the hind wheels, which alone are the driving wheels. It is thus possible to obtain a speed of about 26 feet a minute.

The different electric motors are supplied by a 110-volt current produced by the station that furnishes motive power and light for the docks.

The stability of the crane has been calculated for a load of 150 tons, in view of a wind pressure of about twenty-five tons to the square foot, directed at right angles with the axis of the rolling bridge.

The total weight of the apparatus is 8,237,900 pounds, divided as follows:

Stationary scaffolding and movable framework	6,024,920 lbs.
Rotary mechanism	1,048,520 lbs.
Carriage, windlass and tackle...	1,164,460 lbs

The tests as to resistance were made with a load of 200 tons.

For the mounting, which took two and a half months, a beginning was made with the scaffolding and central part of the movable frame. Then, by means of a temporary scaffold, the upper profile of which corresponded to the lower frame pieces, the rolling bridge was mounted. After one of the arms had been mounted, the movable frame was turned 180 deg., and the same scaffold was used for mounting the other arm.—For the above particulars and the engraving we are indebted to La Nature.

FURTHER DISCOVERIES IN CRETE.

LIKE other Cretan traditions, says Mr. D. G. Hogarth in an article in the Times, the claim of the island to have had a hundred cities is proving not altogether vain. Remains of primitive settlements, too considerable to have been villages, are coming to light at far more points of the Cretan coast than bear a name in classical atlases. There are half a dozen such in a part only of the eastern half isle, and the recent exploration of two among these supplies a key to the rest. One now suspects a Mycenæan site in every larger plain of the periphery. So far as searched at present, these towns show little or no sign of having continued into the historic period. Their civilization was blotted out with the Mycenæan domination. The succeeding class of remains is found for the most part higher up inland, on difficult heights or in remote gorges. The coastal plains were secure no longer. An age of seafaring and communication between ancient seats of luxurious life had given way to one of local and jejune development. But why and how we may only guess.

The crown of the great Cretan civilization was in Mindan Knossos. No other site in the island has furnished, or is likely to furnish, evidences of so high artistic achievement. But there is at least one notable site better preserved. Knossos, owing to its revival in later epochs and the proximity of its site to the mediæval capital of Crete, has suffered wreck and plunder beyond other sites. Much knowledge and more imagination are required to invest with full significance its "shorn and parceled ruin," which, lying low in a featureless valley, conveys no immediate impression of magnificence. One must study its cracked and faded fragments of fresco, and look narrowly into the work of its reliefs and stone vases, to realize why it claims to rival Mycenæ in interest. The house must be reconstituted from its furniture rather than the furniture from the house.

The ordinary visitor, not a specialist, will, therefore, prefer the ruin at Phæstos, on the south of the island, the full revelation of which has certainly been the sensation of the past spring. When Prof. Halbherr announced in 1900 that he had begun upon a lesser Knossos no one expected that he and his Italian colleagues were to find in the event a palace more uniform, complete and imposing. What they have now laid bare stands alone in Crete as a spectacle. Even those fresh from the Mycenæ walls and the Treasury of Atreus, or even from Egypt and Syria, must admire the broad staircases and majestic courts of Phæstos, all on so intelligible a plan and preserved to a point which excites without overtaxing imagination. The ruin covers a promontory of rock. Far below the greatest of Cretan plains stretches to Mount Dicte in the blue distance. Ida hangs right over the site, and through a gap in the screen to west show the snows of Sphakia, all three high masses of the Cretan relief being visible from this one point. In so superb a setting it is the more pity Phæstos should be so difficult of attainment. It may, indeed, be reached in an hour from the sea, but it is from the stormy, harborless Libyan Sea. A steamer that had landed its passengers in the sunrise calm at Dybéki would often be unable to re-embark them at noon. One must ride, therefore, from Candia, making a three-days' expedition, which will include also Gortyna; but the days are long and the paths are rough.

This palace of Phæstos is contained in a vast rectangle, obvious at first sight. There has been an earlier structure, but the building now revealed is of one character and period—that of the acme of the Mycenæan age in Crete. The visitor, approaching from the north, sees, from a terrace, the ruin below distinguished into three main quarters. On his left a broad stairway descends to a spacious paved court, containing an altar and tiers of stone seats built up against the rock, evidently to hold an assembly. Flanking this on the east and raised high above it is the main building, entered by a truly majestic flight of steps, extending the full width of the fine pillared hall at their head. But the entrance from without is from the opposite side, where a second and larger paved court stretches to the brink of the precipice. Thence is admittance not only to the pillared vestibule and main hall, but to a double rank of galleries, and a maze of small chambers to southward, which form the third quarter. This great court, round which the walls and doors are admirably preserved, vies with the region on the west, where the two main stairways meet, as the best point of view on the site. To one standing in it the uses of the various blocks about it are manifest. Here were the living and sleeping rooms of men, there of women. Their common hall of assembly occupies half another side; the store galleries for the produce of the plain fill the other half. In the chambers to south they bathed, worshiped and lodged their retainers and their beasts.

All this is constructed of an excellent limestone, which has retained its sharp and square outlines, while the Knossian gypsums have crumbled and collapsed. The general impression, therefore, is the more convincing. But in details the inferiority of Phæstos is unquestionable. The elaborate frescoes, the sculptured friezes and the delicate plaster relief of Knossos were never here. Phæstos was provincial. It could command good stone and good masons, but not the material or the men for the more subtle crafts. The noble shell was decorated only in the rudest manner, and its ruin is not comparable to that of Knossos as a museum of art. On its plastered walls appear none but conventional patterns of a primitive sort; the only sculptured thing of any note yet found is a fragment of shell; the clay vases are interesting, but of common ware, and fine stone vases have not come to light at all; trinkets in the precious metals or stones have not been found, and two small tablets make a poor show beside the immense clay library of Knossos. Indeed, all the smaller finds are conspicuously wanting. For example, clay impressions of lost signet intaglios, a most valuable class of which Knossos has yielded to Mr. Evans scores of admirable examples, and Zakro some hundreds to me, remain unrepresented among the Italian discoveries.

Certain problems raised by these mid-Cretan excavations it was hoped would be resolved by exploration in the east of the island, the reputed home of the Eteocretan aborigines. There a non-Greek tongue long survived, and at Præsos a short inscription, couched in this language, but in Greek script, had actually been found. The further exploration of that site by the British School of Athens has indeed resulted in a second inscription, broken and imperfect, but containing more words. But no writing in the primitive scripts has come to light there, nor indeed anywhere else in East Crete but at Zakro. Nor has Præsos, while yielding to Mr. Bosanquet several notable objects, been fruitful of anything else having much bearing on the prehistoric problems. Its remains seem to be the leavings of earlier plunderers on the site of a comparatively wealthy community of the Hellenic and Hellenistic ages.

What the Eteocretan capital, however, has failed to produce has come in abundance from two unknown sites, Zabro and Gorynia. These, to compare small to great, stand to one another as Phæstos to Knossos. Gorynia is the more complete and comprehensible. Indeed, it is the most perfect example yet discovered of a small Mycenæan town, uncontaminated with later remains, and at this moment after two great palaces, it is the "sight" best worth visiting in Crete. It lies on the deep gulf of Mirabello, at the head of the lowest and shortest pass to the south coast. Unobserved till now, though close to the main road from Candia to Sitria, it was discovered by the perseverance of the American lady, Miss Harriet Boyd, who has been directing its excavation. Her workmen have now laid bare two narrow and tortuous streets, paved, and here and there ascending by flights of steps, on either hand of which are preserved to a considerable height houses of stone with party-walls of brick. This style of structure, often suspected on Ægean sites, has never been actually found before. The two streets converge toward a large building of fine masonry, on the highest point of the knoll, in which it is easy to recognize the house of the local chieftain or governor. The contents of these buildings are as interesting as their structure. If almost everything in precious metal has vanished, everything in bronze seems to have remained, in the shape of weapons, tools and vessels. Among the many clay vases occur complete specimens of types previously inferred from fragments only; and among the chambers is one which, from the objects and symbols found in it, may safely be inferred to have been a small shrine.

These houses, however, and their contents, though the more intelligible from belonging all to one primitive epoch, are, for that reason, less instructive than the scantier remains which I found at Zakro. For these illustrate all the immense interval between the Neolithic and Hellenic ages. Zakro lay (and lies) remote from the center of civilization, behind high mountains on the extreme southeast angle of Crete. But every captain of sailing craft in the Levant knows its safe bay, and there the sponge fleets, bound in spring for the Libyan shore, muster, take in water, receive the blessing of a priest, and await a favoring norther. It is not wonderful, therefore, that the little plain of Lower Zakro is full of primitive remains, mostly like those of Gorynia, illustrating the close of the Mycenæan age. There are, however, earlier things, for a pit in the limestone rock had been filled with discarded vessels in clay and stone belonging to a previous epoch. Vases in a delicate painted fabric of the same type as the Kamàres ware of mid-Crete occurred here, but they seem more deeply affected by foreign influences. The caves about the plain contained still earlier evidence, having been used for sepulture in an age verging on the Neolithic. But the native objects from all these sources are mixed with elements of outside origin, parallel to things Cypriote and Egyptian.

The main site has suffered greatly from denudation, but the ruins of the town show it to have been of more massive character than that at Gorynia. The houses have like party-walls of brick, but their outer walls are true cyclopean. They are also of great size; one, for example, was found to contain over twenty chambers, and, utterly ruined though it was, it yielded over seventy vases besides many fragments, and objects in silver, bronze and stone. The most productive structure lies on the crown of the knoll, a fragment of a large group of connected blocks, which probably formed the residence of the chief. In one room of this were found not only the two inscribed tablets mentioned above, but a deposit of bronze implements and vases, among which one with decoration of shells and marine stars may claim to be the most graceful of Mycenæan ceramic products. Here, too, were found the hundreds of impressions of lost signets already alluded to, lying in a heap as if once contained in a box, long ago perished. The separate types represented number 150, and illustrate in a remarkable way not only late Mycenæan glyptic art, but also Mycenæan religious symbolism. For instance, we note several bull-headed human figures, associated in two cases with women draped in the typical flounced skirts of the period, pre-Greek Minotaurs and Ariadnes. So well preserved are these impressions that it has been possible to take casts of them for study in England.

The general result of East Cretan exploration seems likely to establish the fact that the Pan-Ægean civilization, which it is agreed to call Mycenæan, was foreign in that part of the island, and that the native civilization, existing before and coincident with it, was much ruder than, and perhaps of different character to that of mid-Crete. If this be really the case an important inference must be drawn, viz., that the Knossian tablets have nothing to do with the Præsos inscriptions, and that the non-Greek language of the latter, if ever interpreted, will supply no key to the most interesting puzzle that Cretan excavation has supplied.—The Architect and Contract Reporter.

SELECTED FORMULÆ.

Moulding Wax.—

Beeswax	8 kilos
Shellac	3 kilos

Melt together in the water bath. This moulding wax gives very smooth, clear casts.

Egg Oil.—

Yolks of eggs (about 250)	5.0 kilos
Distilled water	0.3 kilo

Whisk this together and heat the mass with constant stirring in a dish on the water bath until it thickens and a sample exhibits oil upon pressing between the fingers. Now squeeze out between hot plates, mix the turbid oil obtained with 50 grammes of dehydrated Glauber's salt, shake repeatedly, and finally allow to settle. The oil, which must be decanted clear from the sediment, gives a yield of at least 0.5 kilo of egg oil.

Purified Neat's Foot Oil.—

Crude neat's foot oil	5.0 kilos
Alcohol (90 per cent)	2.5 kilos
Tannin	5.0 grammes

Place in a clearing flask, agitate vigorously and allow to stand for eight days in a warm room with daily repetition of the shaking. Then draw off the spirit of wine on top, rinse again with 1 kilo of spirit of wine (90 per cent) and place the oil in a temperature of about 12 deg. C. Leave it there for at least six weeks, protected from the light, and then filter off the gritty separations in the same temperature.

To Bleach Shellac.—In 80 liters of water stir up 2 kilos of chloride of lime, 110 deg., place the mixture in a wooden vat and add 10 kilos of blond shellac previously coarsely powdered in a mortar. After 24 hours add 10 grammes of sulphuric acid of 66 deg. diluted with 3 liters of water, and after that 50 liters of boiling water. The shellac, which now appears light-colored at the surface, is taken from the bath, kneaded in hot water and then drawn out into bars.

Floor Gloss Varnish (Quick-drying).—

Manila copal, spirit-soluble	12.5 kilos
Ruby shellac, powdered	62.5 kilos
Venice turpentine	12.5 kilos
Spirit, 96 per cent	250 liters

The materials are dissolved cold in a covered vat with constant stirring, or better still, in a stirring machine, and filtered. For the pale shades take light ocher, for dark ones "satinober" (Amberg earth), which are well ground with the varnish in a paint mill.

Fragrant Naphthalene-camphor.—

Naphthalene white in scales	3 kilos
Camphor	1 kilo

Melt on the steam bath and add to the hot mass:

Coumarin	2 grammes
Mirbane oil	10 grammes

Cast in plates or compressed tablets. The preparation is likewise employed as a moth preventive.

Brilliant Blacking.—

Powdered bone black	25 kilos
Dextrin waste	8 kilos
Alum, powdered	2 kilos

Mix, and stir with it:

Molasses	25 kilos
Crude wood vinegar	10 kilos
Water	15 kilos

and when the mass is uniform:

Oil	6.5 kilos

Finally admix 8.5 kilos of sulphuric acid (66 deg.) and pour out at once into tins. The blacking excels in great brilliancy.—Seifensieder Zeitung.

Asbestos Mortar.—Asbestos mortar consists of a mixture of asbestos with 10 per cent of white lime. As reported by the Deutsche Bauhuette, Canadian asbestos is generally used, which is composed of 80 per cent of asbestos and 20 per cent of serpentine. The asbestos is ground and the coarse powder used for the first rough cast, while the finer material is employed for the second top-plastering. This mortar is highly fire-resisting and water-proof, is only half as heavy as cement mortar and tough enough to admit of nails being driven into it without breaking it. According to a test a heavy fire was maintained for 1½ hours in a room 1 1-3 meters in height and provided with a plastering of asbestos mortar; after that a stream of water 40 millimeters in diameter was directed against the walls from a fire hose. The plastering remained perfectly firm and showed no injury. The only disadvantage of this mortar is that it will dry slowly.

Clarification of Dim Varnishes and Alcoholic Shellac Solutions.—Mix the substance to be clarified with one-quarter its volume of benzine and allow to stand for an hour, shaking now and then. After the two liquids have separted into two layers, the upper one will be a solution of the fatty and waxy substances in benzine and below it the perfectly clear alcoholic shellac solution. Decant the former liquid and expel the traces of the benzine taken up, by moderate heating and stirring.—Praktischer Wegweiser.

Cleaning of Copper Plate Engravings.—Wash the sheet on both sides by means of a soft sponge or brush with water to which 40 grammes of ammonium carbonate has been added per liter of water, and rinse the paper each time with clear water. Next moisten with water in which a little wine vinegar has been admixed, rinse the sheet again with water containing a little chloride of lime and dry it in the air, preferably in the sun. The paper becomes perfectly clear without the print being injured.—Papierzeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Conditions in Manchuria.—The Russians in Manchuria.—In a previous report, a reference was made to the resources of Manchuria, much of which has been verified. This was before the Boxer outbreak of last year. Since the Russians have been obliged to enter the territory to protect their railway line, this fertile and promising region has assumed even greater importance, commercially and strategically. There is much exaggeration about the number of Russian troops in this region. The 60,000, which expanded to 100,000 so quickly in the imagination of journalists and theorists, may be safely cut down one-third. It is only necessary to recall the events of last summer—the way in which the great Siberian Railway was taxed to transport the troops actually forwarded at a critical moment—to be assured that it was impossible to transport, feed and maintain so large a force as is credited in Manchuria.

Fertility of Manchuria.—Manchuria has an area of 363,000 square miles and is one of the most fertile countries on the globe. There are no better crops in all Asia. The Manchus have barely scratched the surface, and yet the business activity, the actual traffic, and the tangible results are a continual surprise. Well-informed persons—merchants, miners, officers—assert that it is richer in resources than any other part of China. The main roads leading south and north are said to be congested with the crowds of carts, people, and beasts of burden, all heavily laden, moving in the early winter. During the whole period of navigation, on the river from Niuchwang north, thousands of Chinese boats are continually plying. The volume of business done is estimated at from $50,000,000 to $100,000,000; and yet no part of the land is worked according to European methods, and only the least portion of it is cultivated. Millet, beans, wheat, hemp, indigo, and opium are the principal products cultivated.

Introducing Foreign Goods.—American goods are already known and favored on account of their cheapness—prints, canned goods, watches, clocks, musical and cuckoo clocks, steel, fancy goods, and novelties. One enterprising American merchant has ventured into Manchuria. How far he will penetrate remains to be seen. The Japanese are already on the ground with many successful imitations, as well as their own good articles of merchandise. My Japanese colleague tells me that he has suggested to Japanese exporters to save duties by shipping goods via Port Arthur, Mukden, north.

Manchu *vs.* Russian.—The Russian's policy is one of conciliation. He knows how to deal with Chinese. He will not supersede the Manchu as an agriculturist, however, or even as a miner. It will be some time before he is a success, in the Western sense, in either of these lines.

Exploring Permits.—Last April it was stated officially that all parties wishing to explore Manchuria for mining and other purposes must address their petitions to the agent of the Department of Foreign Affairs at Girin, Manchuria. An official explained this by saying that it was an error to suppose that permission from the Manchu governor would suffice for mining purposes. The hostilities of last year canceled all such permissions, and neither Russians nor Chinese have a right to mine now. It was stated that such permission does not now depend on Russian authority, but upon the Chinese governors, who in turn must await instruction from Pekin. All attempts at mining or exploration in such parts of Manchuria as do not belong to Russia are forbidden, unless under permit, and offenders will be dealt with according to law.

The Gold Fields of Manchuria.—The area of the gold fields in Manchuria extends more than 1,700 versts (1,127 miles) along the shores of the Argun and Amur rivers, from the bed of the Hailar to the mouth of the River Sungari, 400 versts (265 miles) inland. There is no doubt as to the richness of these mines. Several years ago, small parties of Russians illegally mining here obtained from 1 to 3 pounds of gold per day. The average production of these mines is 5 to 6 zolotniks* of gold to each 100 pounds of sand; each man earned from $30 to $100 per day. Until 1888, the Chinese, in consequence of extreme prohibitory laws promulgated by the governors, could not develop the richest mines. When permission was obtained, the Chinese were unfitted for this work, and had not the requisite tools and machinery. At every stage of the development of any of these mines it is safe to say one-half of the gold is overlooked, so primitive and wasteful are their methods.

Foreigners in Manchuria.—It is said that no foreigners are allowed to go into Manchuria. To an extent, this is true. Only Russians and Chinese may go thither overland. It would not be safe for many foreigners to venture into the country now, for outside of the quiet parts about Girin, even military guards could not guarantee safety. At present, Manchuria is no place for tourists, and the authorities would seem to be exercising only proper precaution in discouraging mere sightseers. Passes and permits are only sparingly granted, and naturally not to persons whose mission and character are not clearly known.

Railways.—The line from Nikolsk to Harbin is not in the best working order, nor is it even considered open to general traffic. It was begun under the Cassini concession, and as projected runs in a northwesterly direction through Niugovta, Hu-lan-chui, Tsitzikar, Harbin, to Nagadau, where it strikes the main line. It was started simultaneously from Nikolsk and Harbin and was hastily run together last year. So crudely was the work done that in many places the rails, it is said, were laid upon the bare ground, regardless of the condition of the soil. It is known now that this line as projected, is not practicable, and the present affair is only a makeshift. Harbin was to have been a railroad center, and doubtless will be under better conditions. What is usually marked on the map as Harbin is really "Sungari II;" Harbin is much nearer the river. The new line will form a more northerly curve near the river, following the course of the Sungari, uniting with the present line north of the Mukdeken range, a few versts west of Poltafskaia station. This route presents fewer difficulties of construction, and is in fact more direct than the former one. It is said now the road will be open in the autumn. But there remains the great tunnel of the Chingan Pass, which can scarcely be completed under the most favorable circumstances within a year.

The readiness with which plans are changed and errors rectified illustrates the Russian indifference to mere matters of expense or labor or time when a specific result is desired. All things are subordinate to the end in view. This is shown also in the determination to complete the original railway line as projected along the tortuous Amur, in spite of its many windings and the enormous expense involved. Lines are now marked out to again connect Girin with Mukden, Niuchwang, Wi Ju, Seoul, Gensan, Chemulpo, and Fusan. The Mukden line was connected two years ago, and was operated until the destruction of last summer and the devastation at Harbin. Parts of the Korean system are already in working order.—R. T. Greener, Commercial Agent at Vladivostock.

Disincrustation of Boilers.—Consul Ridgely, of Malaga, under date of August 22, 1901, transmits the following translation of an article recently appearing in Revista Minera Metalurgica y de Ingeneria, of Madrid, the leading journal of its kind in Spain, as of possible interest to our manufacturers and engineers:

The use of zinc to prevent the oxidation of the iron and the incrustation of steam boilers has greatly increased during recent years.

Heretofore, zinc has been employed for this purpose only in the shape of raw pigs, but after many experiments made by the society of "Mines et Fonderies de Zinc de la Vieille Montagne," which have since been confirmed by the British Admiralty, by the national French marine and many great maritime companies, it has been established that compressed laminated zinc made in the form of thick plates for application as an inside boiler lining is greatly superior to the old method. In fact, the galvanic current developed transforms the pig of raw zinc into a more porous substance, in which the metallic molecules are isolated one from the other by the corrosion which is quickly produced, resulting in this, that the intimate metallic contact, which causes the generation of the electric current, is eliminated. Compressed laminated zinc, on the contrary, resists the spongy internal corrosion, as it corrodes only on the surface, thus being very slowly consumed and being capable of conducting the current as long as a metallic nucleus remains. The application of the laminated plates is very simple. They are applied to the walls of the boilers by means of strips and are so distributed that the galvanic action is exercised in an even way, when possible, over the entire surface of the iron. When oxidation is produced in any part of the boiler, it is because the nearest zinc plate is too far away. By this employment of pressed zinc the incrustation of the boilers is avoided, and at small cost.

German Wine Industry.—The wine-producing states of Germany are the Rheingau, Bavarian Palatinate, Baden, Hessen, and Alsace. The Rheingau is a tract of land on the right bank of the Rhine, extending from Eltville to Rüdesheim, 12 miles long and 5 miles wide. Here are located the celebrated Gräfenburg, Steinberg, Marcobrunn, and Johannisberg estates. Within recent years, the wines of the Moselle have come very much into favor. They have a delicate, aromatic flavor and are considered very wholesome. The best qualities are the Brauneberg, Graach, and Pisport. The greatest wine-producing districts are in Baden and Alsace. These wines, however, are of a light quality and are rarely exported, being chiefly consumed in their respective districts.

Germany also produces a very good red wine in Assmannhausen and Ober-Ingelheim, on the Rhine; but the acreage devoted to the culture of this wine is so small that only a limited percentage sold under that name may be said to have been actually obtained from that locality. Germany imports vast quantities of red wine each year for mixing with wines of her own growth. In 1900, 4,788 tons were imported from Italy for this purpose, 1,319 tons from France, 1,272 tons from Greece, 4,878 tons from Austria-Hungary, and 3,478 tons from Spain. These wines were imported solely for mixing, and the fact gains in significance when we bear in mind the duty of $2.50 per ton. In 1897, not less than 2,414,823 gallons of German red wine were mixed with the vintage of southern countries. American firms buying German red wine for import cannot be too careful in their selections. Excellence of quality is incompatible with lowness of price. Good Assmannhausen and Ober-Ingelheim red wine cannot be purchased short of $75 and $50 per 100 bottles, respectively.

Great Britain and the United States are the largest consumers of German wine. In 1900, nearly 5,000 tons of the best Rhine and Moselle vintage were shipped in casks and bottles to the United Kingdom. This is fully 100 per cent more than ten years ago. In 1889, the United States purchased 4,700 tons of various German wines; in 1900, less than 5,000 tons, the shipments of the intervening years retaining the same general average.

The total wine export from Germany in 1900 amounted to 22,199 tons in casks and bottles together, valued at $4,864,720, an increase of 10 per cent over 1890. The wine imports of Germany vastly exceed the exports. In 1900, 75,300 tons in casks, valued at $9,244,400, were imported. Only 788 tons were imported in bottles.

The best wine years in Germany during the past decade were 1893, 1895, and 1897. From all reports, 1900 will also prove a good year. The vintage of 1893 was the best during the whole of the nineteenth century, and exorbitant prices are demanded for the Rheingau wines of that year. Many dealers offer old wines from the years 1811 to 1874, but American buyers should be cautious in ordering any wine older than 1874. It is true that old Rhine wines retain a delicious "bouquet," but they acquire a dead, leathery taste in time. They are often prescribed by doctors as a good wine for patients. It must also be borne in mind that old wines are kept in stock for the general purpose of mixing with other grades and qualities. Wine merchants often advertise for sale so-called historical wines, which have been bought in the cellars of some unfortunate prince or noble family once enjoying affluence and power. Such wines, together with those which have won medals at exhibitions, are sold at enormous prices, fully 100 per cent being paid for the name. These wines, however—especially the old wines—are often wanting in "bouquet" and flavor. The table wines of a good year's vintage will cost from $300 to $500 per 1,000 bottles. The Auslese wines sell on an average of $1 per bottle, while the Cabinet and Cabinet Auslese wines cost from $2.50 to $5 per bottle, respectively.

In buying wines, it may be found preferable to deal with old-established houses which have their places of business in the Rhine country. These firms for the most part have their own vineyards, and possess far better opportunities of buying advantageously than firms located outside of the wine region or in the coast cities.

Some of the most prominent wine merchants are A. Wilhelmj, Hattenheim, Rheingau; P. J. Valckenberg, Worms; Franz Graf, Jr., Geisenheim-on-the-Rhine; H. J. Kullmann & Co., Frankfort-on-the-Main; C. F. Eccardt, Kreuznach, Rheinland. The last-mentioned firm enjoys the reputation of having the largest wine export to the United States. Americans touring Germany should visit some of these wine estates. The cellars of the old cloisters and castles are often used as storage places, the aisles and alcoves being filled with gigantic casks of wine.

Germany also produces a very good quality of champagne. In 1900, 2,045 tons, valued at $547,400, were exported. During the same year, the imports amounted to double that quantity. The duty on champagne imported into Germany is 35 cents a bottle. This high duty has induced many French firms to establish plants of their own within the German border.—Jno. F. Winter, Consul at Annaberg.

Sugar as Food.—Vice-Consul-General Murphy, under date of Frankfort, August 15, 1901, referring to a previous report on "Sugar as Food," printed in Consular Reports No. 238, for July, 1900, transmits the following extract from the Frankfurter Journal of August 12:

"Two scientists have recently reached very different conclusions in regard to the alimentary value of sugar. In recent years experts have shown an inclination to recommend, with great warmth, sugar as an article of food. Now, however, an entirely different view of the matter is taken by Dr. Von Bunge in an article published in The Journal for Biology, under the title 'The Increasing Consumption of Sugar and its Dangers.' This investigator concludes, from the well-known fact that children who eat sugar are pale and have bad teeth, that sugar, owing to the fact that it does not contain enough iron and lime, and that it is substituted for other food containing these materials, has an injurious effect and its use should not be recommended. For this reason, Dr. Von Bunge advocates an increase of the sugar tax.

"Another important physiologist, Prof. Lepine, in Lyons, takes a diametrically opposite position, and shows from Dr. Bunge's own tables that there is very little lime and iron in any of our food. His conclusion is that an increased consumption of sugar could not, for the reasons advanced by Dr. Von Bunge, have a deleterious effect. He, moreover, calls attention to the fact that in France, where, owing to its high price, sugar is really an article of luxury, and where accordingly only one-third as much per head of population is used as in England, the people in general do not seem to enjoy better health than the English and Americans. The only bad result of the large consumption of sugar in these countries appears to be an increased demand for the services of dentists, but even in this respect the English and Americans are probably little worse off than other civilized nations. Prof. Lepine declares that, from the standpoint of a hygienist, he would rejoice to see his fellow-countrymen increase their consumption of sugar three or four fold, and that he would not have the slightest anxiety in regard to the consequences."

An Immigration Scheme in Honduras.—Consul Johnston reports from Utilla, August 20, 1901:

I note in a dispatch, dated New Orleans, August 8, the following announcement:

"James Wood, of Chicago, who went to Honduras as the representative of a Chicago syndicate, has secured from the government 64,000 acres of land on condition of settling it with Americans. . . ."

It happened when the paper containing this dispatch arrived here that President Sierra was visiting the island, and, when shown the article, stated it was untrue that such concession had been made, and expressed much surprise. Mr. Wood claims that his company has made arrangements with a number of Ohio and Illinois farmers to come here, and that the first party of emigrants is expected to leave in two months. I believe, from what I can learn, that the whole business is speculative.

* 1 zolotnik = 4.3657 grammes.

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No. 1154. October 5.—The Electrical High-Speed Experiments at Berlin—German Manufacturers and the Proposed Tariff—Russian Trade in in 1901—Coal Discoveries in Belgium—New Greek Railway.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Gloss Starch in Tablet Form.—B. Setlik and R. Urban have examined four different samples of Bohemian origin and found them to contain 0.10 to 0.74 per cent of stearine and 3 to 7.69 per cent of borax. One of the samples was blued.—Zprávy technol. musea v. Praze, 1900.

For Sweaty Hands.—Rub the hands several times per day with the following mixture:

Rose water	125
Borax	10
Glycerine	8

—Pharmaceutische Zeitung.

Grease for Hemp Ropes.—Cut a quantity of tallow into small pieces and place the latter in a clean vessel on a moderate fire. When melted run the liquid fat through a wire sieve into another vessel, in which mix with constant stirring one-fifth part, by weight, of hot linseed oil varnish, taking care that it is thoroughly incorporated. To this mixture add one-fifteenth part of vaselin. After cooling this grease is applied by means of a wooden spatula on the rope and rubbed in with a clean woolen rag. The grease should preferably be lukewarm when rubbed in.—Uhland's Technische Rundschau.

New Production of Indigo.—J. Ohrigy, of Basle, is, of late, producing an indigo by subjecting a-isatine-anilide in suitable solution to a reduction by means of ammonium sulphide. For this purpose he causes, for example, 40 kilos of a freshly prepared ammonium sulphide solution containing 10 per cent of hydrogen sulphide to flow quickly and with constant stirring into a heated solution of 20 kilos of isatine-anilide in 60 kilos of alcohol. With spontaneous heating and temporary green and blue coloration an immediate separation of indigo in small crystalline needles of a faint copper luster takes place. Finally he continues heating for a short while to a boil, whereupon the indigo is filtered off, rewashed with alcohol and dried.—Pharmaceutische Centralhalle.

Investigation of Colored Honey.—According to a statement by A. Boemer, there are offered for sale artificially colored varieties of honey; also such as are produced from natural honey and yellow rock candy. For the detection of the artificial yellow dyestuff it is recommended to treat the aqueous yellow solution with hydrochloric acid, as well as with ammonia; also to extract the dyestuff from the acid or ammoniacal solution by solvents, such as alcohol or ether, or to conduct the Arata wool test in the following manner: Dissolve 10 grammes of honey in 50 c. cm. of water, mix with 10 c. cm. of a 10 per cent potassium bisulphate solution and boil the woolen thread in this liquid for 10 minutes.—Zeitschrift für Nahrungs- und Genussmittel.

Remedies for Dry Rot.—A good remedy for dry rot is petroleum. The sick parts of the wood are painted with it, which causes the fungi to die, turn black and finally drop off. The best preventive of dry rot is plenty of draught. If the portions are already affected so badly that they have to be torn out and renewed, the freshly inserted wood is coated with "carbolineum" to prevent a fresh appearance of dry rot.

Another remedy is ordinary salt, which is known to have a highly hygroscopic action. It absorbs the moisture of the wood, whereby it is itself dissolved, thus gradually impregnating the planks, etc. In order to combat dry rot with salt, proceed as follows: Throw salt into boiling water until a perfectly saturated solution is obtained. With this repeatedly wash the wood and masonry afflicted with dry rot. Wherever practicable the salt may be sprinkled direct upon the affected place.—Baierisches Handels Blatt.

Protection for Iron Pipes.—A simple and efficacious method of tarring iron pipes to protect them from rust is worthy of being quoted. The pipes are coated with coal-tar and are next filled with light wood sawdust, which is set afire. It has been found that this process amply protects the iron from rust for an unlimited period, rendering a subsequent coating perfectly unnecessary. As proof thereof an iron pipe flue is cited, which remained unattacked by rust for a number of years. Owing to the great heat of the iron, which is first painted with tar on the outside, the latter is said to burn into the iron, thus stopping up the pores and acting as a preventive of rust in a more perfect manner than if the tar is previously heated by the ordinary processes and applied to the cold iron. Care has to be used, of course, not to heat the iron too much or too long, so that the tar does not burn up. For this reason it is advisable to employ light wood sawdust instead of any other fuel. —Seifensieder Zeitung.

The Emerald.—The diamond is no longer the most expensive gem. As regards monetary value, it is far surpassed by the ruby and emerald, and even the pearl is rated higher. The emerald is at present the most fashionable stone, and enjoys such favor because it is daily becoming rarer. For a number of years hardly any new emeralds have been found, and the greater the demand becomes the more rapidly the price rises. It is a fact that an emerald of medium size and purity, which five or six years ago may have cost about $50, could not be had to-day for less than $250. And the absolutely flawless stones of the purest transparent green fetch prices which must appear absurd to the layman. Thus, only latterly $875 was asked and paid for an emerald of three carats, while a six-carat stone went at $4,000. A diamond of exactly the same size and water, however, costs but $1,000.

As regards rubies, the paler Oriental stone continues to be more valuable than that of dark, glowing red, which is found in Siam. In the same manner, the pale sapphire from the Island of Ceylon is much more costly than the deep blue stone from other parts of India.

It must not be assumed, however, that diamonds are depreciating in value, which is not at all the case; other stones, and especially emeralds, simply have risen in price of late in a surprising manner.—Die Edelmetall Industrie.

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